THE EYES

IN HEALTH AND DISEASE

SKINNER

THE

CARE OF THE EYES

IN HEALTH AND DISEASE

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CHAPTER I.

INTRODUCTION.

IN the course of his professional life, the physician finds himself often appealed to for relief by those whose maladies are the sole result of natural laws, acting upon a system so entirely out of harmony with an intelligent obedience to the dictates of even an uneducated judgment that the grossest outrages are being constantly perpetrated upon its delicate, though long-resisting, tissues and functions. Could the vast amount of suffering brought upon the human family through ignorance of the physiological offices of the human body be computed in money values wholly, the growing speculativeness of the race would demand of every person something more than a common-school education as to the anatomy, physiology and hygiene of his corporeal system. And yet, if a

proper regard for the laws of life and health, which should be paramount to legal tenders, is to be made subservient to an ambitious struggle for wealth and renown, what must be the future of the race upon whose children the iniquities of the fathers are visited, not only to the third and fourth generation, but through all time?

Having in mind Pope's assertion that "the proper study of mankind is man," the writer of these Practical Talks has, from the standpoint of the ophthalmic surgeon, for a long time felt the necessity for the existence of some concise, simple and practical information regarding the care of the eyes, which could be placed in the hands of all who might deem it for their best interest to know more of themselves; for if there is any part or organ of the body about which people know little or nothing, and about which superstition runs riot, it is the organ of sight. And it is no doubt true that much of the abuse which is heaped upon the eyes, and which is out of all comparison, often, with that imposed upon other portions of the system, is due, in great measure, to this profound ignorance.

This little work is designed to present, in a concise and comprehensive form, such elementary knowledge as shall enable the reader to understand something of the function of sight, and also enable him to more judiciously control the conditions under which the

eyes may be safely used, as well as to place him on his guard by a hint at the danger signals which, thrown out here and there, warn of impending disaster. Diseased conditions of the eye, with appropriate treatment, belong to the domain of medicine and will receive but passing notice here, a sufficient reference only being made to enable the sufferer to intelligently pursue the proper course in seeking relief. To teach the prevention of disease of this organ is the aim of the writer, for through the loss of function of no other organ of the body is so much unhappiness and dependence brought about as in loss of sight.

In order to assist in a better understanding of the subject which forms the burden of this little manual, and the more intelligently to aid in the proper care and use of the eyes, it is necessary to have some understanding of their anatomy and the physiological principles involved in the performance of their function. The reader's attention is therefore solicited in a careful perusal of the preliminary chapter, which is not intended, indeed, to be an exhaustive description of the make-up and functions of the eye, but merely to present a general and, it is hoped, satisfactory resumé of the different tissues which together make up the eye, and through the properly performed offices of which the integrity of the sound and normal eyes is maintained.

CHAPTER II.

ANATOMY AND PHYSIOLOGY OF THE EYE.

The delicacy and beauty of the organ of vision has challenged the admiration of the world for centuries, so wonderful is its utility and so well adapted is it to the purposes of conveying to the inner or spiritual nature of man an expression of the form and beauty of the natural world with which he is so intimately associated.

The eyeball is globular in shape, about seven-eighths of an inch in diameter, and is placed in a bony cavity, called the orbit, which serves to protect it from injury by a strong ridge of bone which surrounds this cavity. It rests upon and is partially incased in a bed of adipose tissue, which is seldom absent even in extreme emaciation. Covering the posterior two-thirds of the eyeball, and serving as a support for the eye and a socket in which it may rotate, is a membrane called Tenon's capsule. The eyeball is held in its position and rotated in its socket by six muscles

(Fig. 1) having their attachment at the inner and posterior wall of the orbit. These are: the internal and external recti, whose office it is to move the eye from side to side; the superior and inferior recti, which move the eye upward and downward; and the superior

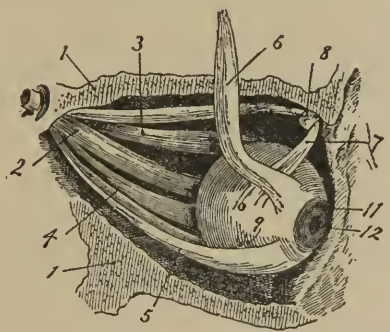


Fig. 1. — MUSCLES OF THE EYEBALL: 1, Edges of the orbit, upper portion removed; 2, Optic nerve, extending from back of eyeball to the brain; 3, Internal rectus muscle, which turns the eye inward; 4, Inferior rectus muscle, which turns the eye downward; 5, External rectus muscle, which turns the eye outward; 6, Superior rectus muscle, which turns the eye upward (cut from its insertion in the orbit and turned upward); 7, Superior oblique muscle, which rotates the eyeball; 8, Pulley, through which tendon of this muscle passes; 9, Attachment of inferior oblique muscle; 10, Sclerotic coat of eyeball; 11, Cornea; 12, Pupil.

and inferior oblique, which serve to rotate the eye upon its antero-posterior axis. These muscles derive their stimulus from three pairs of nerves having their origin at the base of the brain. The internal rectus, the superior and inferior recti, and the inferior oblique

muscles are supplied by the third nerve, so called. The superior oblique muscle only is supplied by the fourth nerve, while the external rectus is supplied by the sixth nerve. It is the even and proper balance of these muscles which keeps the eyeballs in proper position for single vision. Should one muscle act in excess of its opponent it will draw the eye around and produce what is termed squint. Very much pain and discomfort is produced in the eyes by a weakness of some of these muscles, say of the muscles which converge the eyes so that they may be focused upon the book one is reading or the near work. The strain which is unconsciously made to maintain this convergence is a very frequent cause of pain and "running together" of the print when reading is indulged in.

The eyelids serve the purpose of protection and lubrication of the eyeball. The general shape and contour of the lids is maintained by the presence between the outer skin and the lining of the lids of a cartilaginous structure, which is much larger in the upper lid than in the lower, and which, in a normal condition, possesses the same curvature as the front of the eye, over which it moves in the act of winking.

These cartilages are covered on the outer side with cellular tissue and the thin, loose skin which in most people lies in slight folds or creases above the lid. On the inner side of the lid is a smooth, delicate,

mucous membrane called the *conjunctiva*, which not only lines the eyelids but covers the whole front of the eyeball and is continuous with the tear ducts, extending itself into the nasal passages and becoming continuous with the mucous membranes of the nose, throat and bronchial tubes.

This delicate membrane is liable to irritations from foreign bodies becoming lodged upon the eye, from the effects of colds and catarrhal conditions extending from the nose through the nasal ducts, and from disturbances of the circulation of the blood in the head. It is also subject to changes in its structure by prolonged irritation, which gives rise to follicular or granular conjuctivitis, as it may be. These are conditions which, unless met and combated in the earlier stages, give rise to serious defects of sight, by producing a thickening of the delicate structure of the cornea.

In the outer border of the free edge of the lids the eyelashes are inserted. They are placed here by a wise provision, for they not only add much to the comeliness of the face but through their sensitiveness they serve to convey a warning to the eye of the approach of a foreign invader, such as an insect or particle of dust which may come in contact with them. The lashes have the peculiar faculty of attaining the stage of retirement from business after an existence of six months, and then quietly drop out of the ranks,

giving place to those which are to follow. They are sometimes subject to vagaries in the direction and number of their growth, producing in some people a double row on each lid, in others assuming a variety of directions, among the most annoying of which is a tendency to grow inward and by their constant friction upon the eye give rise to inflammation of the eyeball and, perhaps, eventually blindness unless removed frequently or radically changed in direction by an operation.

At the inner border of the edge of each lid are situated thirty or more small glands which have their openings near the insertion of the lashes and whose office it is to secrete and throw out, along the edge of the lid, a peculiar oily substance, the apparent object of which is to prevent the tears from running over the edge of the lids upon the cheek.

The apparent size of the eye is governed in most instances by the extent to which the lids are separated. In some people the opening between the lids, which is called the commissure, may be so large or so small as to elicit remark as to the largeness or smallness of the eye, as it may be. The expression of the face is modified to an almost incredible degree by the peculiar forms which may be given this commissure. In the different races of men this is a marked peculiarity. In disease it is often a guiding feature, and the story which it tells is not often un-

mixed with solicitude as to the future of the opium *habituæ*.

Very near the inner angle of the lids, both upper and under, are to be seen minute openings at the summit of little papillæ. These are the *puncta lachrymale*, and are the openings into the lachrymal canals, or tear ducts, by which channel the tears are conducted into the nose. The tears are secreted by the lachrymal gland, which is lodged in a slight depression near the upper and outer edge of the orbit. After being poured out through several small ducts upon the surface of the eye, the tears fulfil their mission of lubrication and are conducted off through the lachrymal canal into the nose.

The office which the tears are designed to perform is an important one in the economy of the eye, and no little discomfort is produced by a disturbance in quantity and quality of this fluid. A foreign body lodged upon the eye, by a provision of nature, excites an excessive flow of the tears which are intended for its removal. The emotions, also, either of excessive joy or sorrow or pain experienced, bring the tears to the eyes in abundance, through an effect upon the lachrymal gland. In cases where an obstruction exists in the ducts which convey the tears into the nose, a condition popularly known as "the watery eye" exists, and can only be relieved, in long-standing cases, by a systematic dilatation of the ducts by probes.

The eyeball itself (Fig. 2) may be described as composed of three membranes or tunics constituting its external portion, and the aqueous and vitreous humors which, together with the crystalline lens, fill its interior. The sclerotic coat forms what is known as

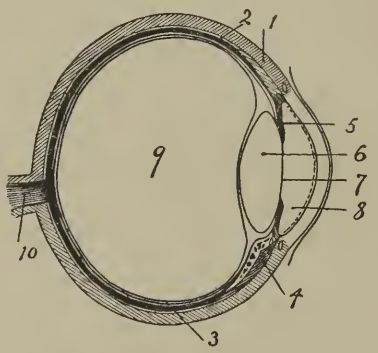


Fig. 2. — SECTION THROUGH THE EYEBALL, SHOWING THE RELATION OF ITS MEMBRANES, ETC. : 1, Sclerotic; 2, Choroid; 3, Retina; 4, Ciliary muscle; 5, Iris; 6, Crystalline lens; 7, Pupillary space; 8, Aqueous humor; 9, Vitreous humor; 10, Optic nerve.

the "white of the eye." It is composed of white, fibrous tissue, very tough and resisting, and by its firmness maintains the shape of the ball and protects the delicate internal structures from injury. It furnishes points of attachment for the muscles, and allows the entrance and exit to nerves and blood-vessels which supply the interior. This membrane occupies the posterior five-sixths of the eyeball and

varies in thickness in different parts, being thickest at the back of the eye and thinnest at the middle portion. A circular opening at the posterior portion of this membrane forms the entrance of the optic nerve to the inner layer.

The cornea is a perfectly transparent membrane continuous with the sclera but having a less curvature. It occupies the anterior sixth of the globe of the eye and has an attachment to the sclera similar to the insertion of a watch-glass in its frame. This membrane is supplied with minute lymph spaces through which its nutrition is kept up. It has no bloodvessels except a narrow zone at its periphery. It is composed of five separate layers, but it is not necessary to describe them here.

Just internal to the sclerotic coat lies the choroid. This membrane consists of a light framework of connective tissue, holding in its meshes the numerous bloodvessels, pigment cells and nerves which make up the bulk of its substance. It lies in contact externally with the sclerotic and internally with the retina, and by its numerous bloodvessels nourishes the retina and crystalline lens.

The iris is a circular, disk-like membrane, attached at its outer border to the ciliary body and forming a curtain across the interior of the eye. It lies just in front of the crystalline lens, with the pupillary margin resting upon the capsule of the lens. The round

opening in its centre is called the pupil. The office which the iris performs is one of considerable importance to the eye in regulating, by contracting or expanding the pupil, the amount of light which should enter the eye in order that we may be enabled to see well both in dim and very bright light. When we are in a dark room, or in the night, the iris expands the pupil so that all the light possible may impinge upon the retina, that we may see the clearer. In brightly lighted places the pupil contracts to a very small point, and thus, by admitting a few rays only of the intense light, the eye is not made painful. This action of the iris is an involuntary one, and is brought about by the action of two sets of muscles which comprise a portion of its structure. The circular fibres of one, by contracting, draw the pupil down to a pin-hole opening, while the contraction of the radiating fibres pulls it open. In fœtal life the pupil is closed by a membrane, which in some instances remains after birth, to the great detriment of vision.

It is the iris which gives to the eye its color and upon which its beauty to a great extent depends. The temperament of the individual, the color of his skin, or rather the amount of pigment in the skin, determines, to a great extent, the color of the eye. Dark people usually have dark eyes, and light-skinned people blue or light ones. In hot countries it is

usually the case that the pigment in the iris is more abundant, giving the eyes a darker hue than those possessed by people living in colder climates. In albinos the eyes are very light and often pinkish in color, this being due to a reflection from the blood-vessels of the choroid. Eyes deficient in pigment are always deficient in sight and painfully sensitive to light, against an excess of which they are deficient in the natural protection afforded by the presence of a proper amount of pigment. The eyes of newly born infants are almost invariably blue, and not until two months of their infantile existence has passed do they begin to assume the color which is to be their distinguishing feature.

The action and size of the pupil offers important evidence in certain forms of disease, especially those which are connected with the brain and nerve centres; also in certain diseases of the eye itself. The action of some poisons, like belladonna, applied to the eye or taken in excess, dilates the pupil widely; while others, like Calabar bean or an over-dose of opium, will contract it to a very minute opening. In old age the pupil is naturally much smaller than in youth — a wise provision of nature in preventing the dispersion of rays of light as they pass through a hazy crystalline lens.

The retina or third membrane of the eyeball is a soft, transparent membrane, whose office it is to re-

ceive the images of external objects upon its sensitive surface and transmit the impression to the brain. This membrane is continuous with the optic nerve and extends forward to the ciliary processes near the anterior portion of the eye. Its thickness varies from one one-hundred-and-twentieth to one two-hundredth of an inch, but even this extreme thinness has been described by microscopists as exhibiting eleven distinct layers, each having its peculiar formation and function. The layer of rods and cones, which is one of the posterior layers near the choroid, need only employ our attention here, as it is this layer, called the percipient layer, upon which devolves the duty of receiving the impression of objects in the external world and, by the aid of the conductive layer, telegraphing to the brain the impression received, where it is recorded, awaiting the mental impulse. This interesting layer of the retina is shown by the microscope to be composed of parallel layers of cylindric and cone-shaped elements placed side by side perpendicularly to the plane of the retina. These form a connection with the nerve-fibre layer, which in turn, by an aggregation of nerve-fibres, forms a considerable nerve trunk called the optic nerve, which passes through the sclerotic at the back of the eye and becomes intimately connected with the brain.

The optic nerve forms the medium of communication between the eye and the brain. The relationship of

these two organs is thus most intimately established by a royal roadway along which the nerve-fibres from the retina are conducted, and through which the brain, as by an electric flash, is made conversant with every impression or impulse received upon the retina.

The cavity of the retina is filled with a gelatinous and slightly alkaline transparent material called the vitreous humor. It is enveloped in an exceedingly delicate and structureless capsule called the hyaline membrane. This jelly-like substance occupies four-fifths of the interior of the eye and furnishes an even and gentle, though firm, support to the retina.

The aqueous humor is made up of very nearly the same constituents as pure water, and occupies the space bounded by the cornea in front and the iris behind. The space in front from the cornea to the iris is called the anterior chamber of the eye, and the space posterior to the iris and constituting the small cavity lying between it and the crystalline lens is called the posterior chamber.

The crystalline lens rests in a cavity or depression just in front of the vitreous humor and posterior to the iris. It is enveloped in a thin, transparent and very elastic membrane called the capsule. The lens is kept in its position by the suspensory ligament — a delicate structure which extends about the periphery of the lens and is attached to the anterior edge of the choroid.

The lens is composed of crescentic layers surrounding a hard nucleus, often described as resembling the layers of an onion. Its purpose is to so refract rays of light entering the eye that they shall become accurately focused upon the retina, and thus produce a sharply defined image of objects looked at. As the age of the individual increases the lens increases in hardness and sometimes becomes opaque, constituting cataract. Farther on I shall have more to say about the function of the crystalline lens in its connection with accurate vision.

CHAPTER III.

THE PHYSIOLOGY OF VISION.

The function which it is the duty of each and every tissue of the eye to perform, and the laws which govern the visual act, are most worthy objects of our careful study. From the earlier days of conjecture to these of greater exactness in physiological science there has been no part of the human body more thoroughly and yet unsatisfactorily investigated than the eye. The strictly physical processes of the act of vision are more clearly understood, for the laws which govern the refraction of light-rays are as applicable to the eye as to the photographer's camera. But deeper than these known laws lie others whose foundations rest upon the hidden mysteries of the Infinite, for as inscrutable as is the union of spirit and matter to our mortal understanding so is the union of these two processes of vision — the purely physical, and that which conveys to our intelligence the form and impress of objects whereby the intellect

and reasoning faculties are excited to responsive and concerted action. Scientists have sought to obtain some clue to the phenomenon; but, while beckoning an advance, like the ignis-fatuus, the problem eludes the grasp of the mind, and at every attempt at a solution the would-be investigator at length finds himself face to face with the incomprehensible.

The perfect adaptation of the eye to all the requirements of vision does not depend so much on its perfection as an optical instrument as on its free mobility, the great sensibility of the retina, and the readiness with which the mind interprets the impressions conveyed to it. The comparison which is so often made to the photographer's camera is physically speaking a correct one. The dark chamber and the convex lens, which forms an inverted image of objects on the screen in the chamber, are represented by the pigment-lined cavity of the choroid and the combined refractive media, — the cornea, aqueous, crystalline lens and vitreous, — whilst the sensitive plate of the photographer's chamber corresponds to the retina. Unlike the camera, however, the eye is endowed with a capability for immediate self-adjustment which fits it for the instantaneous reception of objects either at a long distance or close at hand.

In order to clearly understand the method by which images are formed on the retina it is necessary to call to mind the laws of refraction as applied to the action

of light-rays when passing through transparent materials of different density and shape. As long as a ray of light travels in the same medium its direction will continue the same, however far it may be transmitted; but if it is made to pass into a medium having a different density its direction becomes changed as soon as it reaches the surface of the medium into which it passes, provided it does not fall perpendicularly to the surface separating the two media, in which case it continues its course without undergoing refraction. As the refracting power of a medium is proportioned to its density, as a general rule, we find that glass has a greater refracting power than water; and that water has more than the atmosphere. A good illustration of the refraction of rays of light when passing from the air into water may be shown by placing a small object upon the bottom of a basin in such a position

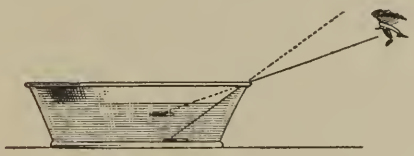


Fig. 3.

as to be just concealed from the eye of the observer as he looks over the edge of the basin. Now if water is poured into the basin the object at the bottom is brought into view. (Fig. 3.)

A ray of light as it falls upon a prism of glass undergoes refraction in its passage through, and again on its exit at the opposite side, in each instance being bent toward the base of the prism. If an observer holds before his eye a prism and looks

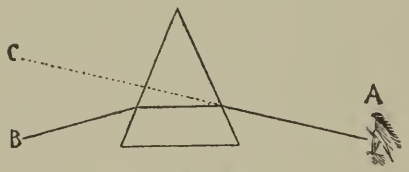


Fig. 4.

through it at an object the rays of light emanating from that object make the object appear in a false position. Thus, let the prism be held before the eye with its base downward: the eye at A will receive rays of light from the object at B, which will appear to it as if coming from C; i. e., in a straight line. Thus the object seen appears to occupy a different position from what it really does. (Fig. 4.)

All convex and concave lenses may be regarded as made up of prisms; convex lenses of prisms with the bases together, and concave lenses of prisms with their apices together. (Fig. 5.) Consequently, convex lenses must converge rays of light passing through them, while concave lenses will render them divergent. When parallel rays of light pass through a convex lens they meet at a given point on the other side more

or less distant from the lens according as the lens is less or more convex. The point where the rays meet is termed the principal focus of the lens, and the distance from it to the lens is called the focal length of

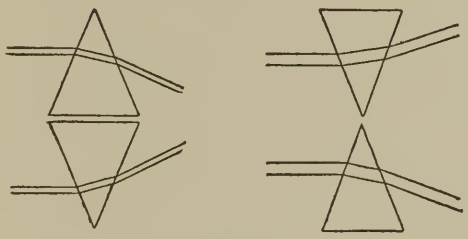


Fig. 5.

the lens. If the rays of light enter a convex lens in a divergent manner, as those coming from a near object, they will not meet at the principal focus of the lens, but will be prolonged so as to meet at a point a greater or less distance away according to the distance of the object from the lens. If the object is placed just at the principal focus of the lens the rays passing through the lens will become parallel on emerging. If the object is nearer the lens than the principal focus, rays from it will emerge divergent, but to a less degree than on entering. Let the converse of this principle be applied to concave lenses and we can readily see what effect must be produced on rays of light passing through them. If now we apply this principle of the action of lenses on the refraction of

light to the media of the eye no difficulty need be experienced in understanding how the rays from external objects become focused upon the retina so as to produce a sharply defined image there. In a normal eye rays of light emanating from an object looked at from a distance of twenty feet or more are so little divergent that they enter the eye in a practically parallel direction and are exactly focused, by means of the cornea and crystalline lens, at a point on the retina without the expenditure of any effort in the eye to adjust itself to the proper focus. This will produce a sharply defined image there, of the external object, if the media of the eye are clear and the retina in a healthy and normal condition.

Let Fig. 6 represent the eye in normal refraction and A, B represent the object looked at. A pencil of

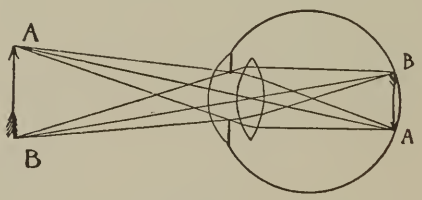


Fig. 6.

rays in passing from A through the cornea and lens will impinge upon the retina at A′, and will form there an image of the point from which they came; while the rays from B will be focused at B′, forming there an

image of B. In a similar manner rays emanating from any point between A and B will form an image at corresponding points on the retina between A′ and B′. As will be readily perceived, then, images of objects looked at are reproduced on the retina in an inverted position. This fact of the inversion on the retina of the object looked at has led to much discussion in the past among physiologists, as to how we perceive the object looked at in an erect position. A satisfactory answer to this problem lies in the fact that rays of light reaching the retina from outward objects are, in ordinary conditions, returned to that object in the same direction as that by which they entered the eye, producing an "outward projection" corresponding to the object itself in its proper and erect position.

The sensibility of the retina to visual impressions varies very much at its different parts. The central point of the retina, where impressions are most sharply defined, is a spot situated directly in the line of vision, called the yellow spot of Sommering or the *macula lutea*. In the centre of this yellow spot is a slight depression called the *fovea centralis*. This yellow spot exists only in the eyes of man and the quadrumania. The ability of the retina to define objects diminishes rapidly from this central point toward the periphery, owing to the greater scarcity of the cones in the deeper layer, so that as the outer portion is approached the color of objects first dis-

appears, then the form, until at length only a visual impression, dim and undefined, remains in the periphery of the visual field. When we look at an object the eye is so readily and unconsciously placed in a position so that the yellow spot may receive the impression, that defects in the periphery of the field are scarcely noticed. In fact, quite indistinct lateral vision is not incompatible with perfectly sharp direct vision. Experience has so formed the character of visual impressions that no one, unless his attention were called to the fact, would be aware that a gap exists in the visual field of each eye sufficient to include a man's head at a distance of seven feet. Such is the fact, however, and it is situated just a little to the outside of the line of direct vision. It is caused by the circular opening in the tissues at the back of the eyeball through which the optic nerve enters the eye, and over which, as a matter of course, the percipient layer of the retina does not extend. This blind spot in the retina is situated at from one-twelfth to one-eighth of an inch to the inner side of the yellow spot and is about one-sixteenth of an inch in diameter. The existence of this blind spot may be easily demonstrated by means of an ordinary visiting card, near the left-hand edge of which a small cross may be made with pen or pencil and at the right-hand edge a circular blackened spot three-eighths of an inch in diameter; the cross and black spot being

from two to two and a half inches apart. Now close the left eye and direct the right to the small cross, holding the card ten or twelve inches from the eye, when both the cross and the circular black spot will be clearly seen. If now the card be brought gradually nearer to the eye it will reach a point, from six to seven inches from the eye, when the image falls upon

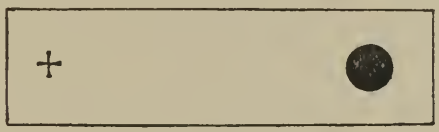


Fig. 7.

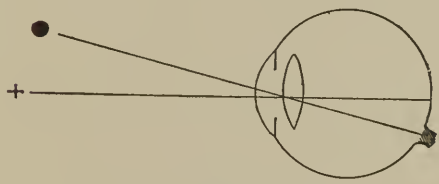


Fig. 8.

the optic-nerve entrance and the black spot passes entirely out of view. Figs. 7–8 illustrate the manner in which this takes place.

The wonderful adaptiveness of the organs of the body to the requirements of our nature is nowhere more clearly shown than in the provision of two eyes, whereby objects are not only more clearly discerned than with one, but by means of which we are enabled

the better to estimate the size, distance and color of objects than if we possessed one eye only. This simultaneous use of both eyes is called "binocular vision," and it is essential for the most perfect results that both eyes have very nearly the same acuteness of vision; that the refraction be nearly the same, and that both eyes be so evenly poised by the action of the external muscles that rays emanating from the object observed may be focused on exactly corresponding points in each eye. The yellow spots, being the central points of vision, would of course afford the most accurate sight; but double vision is not produced unless the images fall upon other than corresponding points of the two retinæ, when two objects will be at once perceived.

In those eyes where a lack of symmetrical action in the muscles exists, double vision becomes an exceedingly annoying circumstance. If the vision in one eye is much poorer than in the other, or if the refraction of the two eyes is quite different, so that the work of seeing falls more heavily upon one than upon the other, the eye which sees the poorest is quite apt to wander from a position of coördination with its fellow, in which case exactly corresponding spots in the retina of each are not illuminated, and double vision is the result. In these annoying conditions nature provides a remedy, and soon causes a suppression of the transference of impressions from

the erring eye to the brain, so that those made upon the retina of the most useful eye alone are perceived. And this state of things is so gently and imperceptibly brought about that in many cases the individual is not aware but that he is seeing with both eyes and enjoying binocular vision.

The advantage to be derived from using both eyes simultaneously, as nature would have us, is the same as that which we derive in looking at a stereoscopic picture; that is, we see as much of the lateral portions of an object — right side with the right eye and left side with the left eye — as is sufficient to cause the object looked at to stand out in relief, thus obviating the general flat appearance which many pictures have, and which is one of the results of having but one eye to see with. People who have lost the sight of one eye, although they may soon become so accustomed to the loss that they suffer no apparent inconvenience, are yet incapacitated for exactly placing the position of an object, as may be proved by closing one eye and making an attempt to thread a needle or to quickly touch a given point with the finger. Education, which comes from habits long indulged in, finds in the process of correctly seeing a confirmation of the assertion that we are to a great extent what custom and practice instinctively make us.

CHAPTER IV.

DEFECTS OF VISION.

The causes of imperfect vision are numerous, and for the sake of convenience they will be classed here under two general heads: those which are inherent in the eye and functional in character, such as errors of refraction, congenital defects, etc.; and those due to injuries and diseases, which will be considered in their proper order.

As has been remarked in a previous chapter, the normal eye is so adapted in the adjustment of all its parts that rays of light from objects seen are accurately focused upon the retina so that a sharply defined image is produced there. It frequently happens, however, that an eye may be perfectly sound and free from disease, and yet vision be quite defective, from the fact that light-rays are not exactly focused upon the retina, either falling short of it and becoming focused before reaching the retina, or impinging upon the retina before coming to a focus. Such conditions

constitute what are termed errors of refraction, and take the names of: *hypermetropia*, when the eyeball is too short from before backward, bringing the retina too near the front of the eye for the rays to be focused; *myopia*, when by unusual length of the eyeball from before backward the retina is carried too far away and rays are focused before reaching it; and *astigmatism*, when the refraction is stronger in one meridian of the eye than another, bringing some rays to a focus while others are not so brought.

Hypermetropia, or far sight, as it is popularly but erroneously called, is a condition of the eyes quite commonly met with, and constitutes a source of much pain and inconvenience in the use of the eyes, especially in near work and as one grows older. The defect is a congenital one, and is due either to an arrest of development in the eye from before backward, making the eye so short in that axis that parallel rays of light do not come to a focus before reaching the retina, or to a diminution of the refracting power of the media, either by a flattening of the cornea, diminished refracting power in the crystalline lens, or absence of the lens. (Fig. 9.) In childhood and in early life hypermetropia, if not of a high degree, may produce little, if any, inconvenience, owing to the fact that the crystalline lens, being soft and pliable, is easily acted upon by the ciliary muscle and is made more convex, so as to give the rays enter-

ing the eye the proper direction for an exact focus upon the retina. This action of the circular muscle which surrounds the crystalline lens, which by its contraction causes the lens to become more convex,

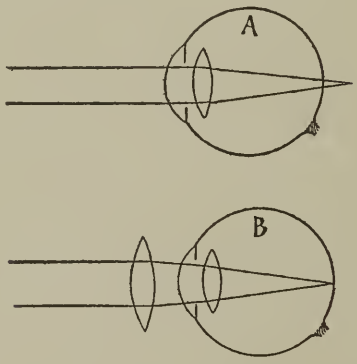


Fig. 9. — A, Illustrating the direction of light-rays in hypermetropic eyes; B, Illustrating the effect of a convex lens placed in front of the eye for the purpose of correctly focusing the rays upon the retina.

constitutes what is known as the accommodation of the eye, about which more will be said farther on.

The symptoms which the sufferer from hypermetropia experiences are those of fatigue of the eyes after a little use of them, with, perhaps, pain in the brows and a feeling of dizziness, and, in some cases, great mental confusion. At first the victim of hypermetropia experiences only inconvenience on using his eyes continuously for near work. After a while, and as time advances, the natural hardening of the crystal-

linc lens renders the effort of accommodation, which has previously, perhaps, been unconsciously exercised for distant vision, quitc difficult and painful, and the eyes become continuously a source of irritation and often of positive pain. In many people this condition of the refraction, if allowed to go uncorrected by the proper glasses, induces a series of nervous disorders which tend to make life a burden to them. They suffer from irritability of temper, nervous prostration, and sick or nervous headaches, for which medicines, as a matter of course, are prescribed without relief. People possessing different temperaments are affected in different ways and in varying degrees. In children, very often, the first indication of anything wrong with their eyes is shown in the holding of the book or playthings very near to their face, and they are therefore supposed to be near-sighted. Short-sightedness is, however, rare in young children, and under the circumstances just mentioned hypermetropia should always be suspected.

In high degrees of hypermetropia the constant effort of the ciliary muscle to hold the crystalline lens in a state of greater convexity often results in a state of tonic contraction, by which the eye is maintained in a condition of accommodation for the near point, so that distant vision is always poor and near vision good; a condition of things not only productive of pain to the sufferer, but which so much resembles

short-sightedness as to induce the unskilled to prescribe for their relief a concave or near-sighted glass, which is, of course, the very worst thing which can be done for them.

In moderate degrees of hypermetropia, especially in children, a degree of accommodation just sufficient to induce a state of constant convergence of the eyes is called into action, and there often results a turning in of one eye, or squint. This is the most potent factor in the production of cross-eyes in children.

Myopia, or short sight, is the result of a condition

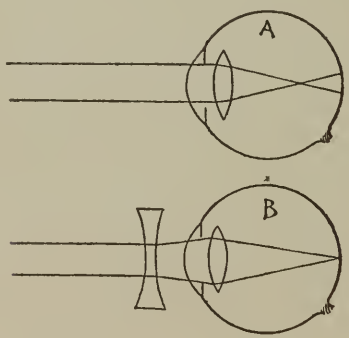


Fig. 10. — A, Showing the direction and focussing of light-rays in a myopic eye; B, Illustrating the effect of a concave lens in causing divergence of rays so as to focus them on the retina.

of the eyeball the opposite of that which produces hypermetropia. (Fig. 10.) That is, as in hypermetropia the eyeball is too short in its diameter from before

backward, in myopia it is too long from before backward. This condition of things carries the retina back beyond the focal distance of the crystalline lens, and parallel rays of light do not, therefore, reach the retina before meeting and becoming dispersed. This, of course, must result in a very dim and blurry perception of the object looked at, unless that object is brought so near the eye that rays from it must enter the eye in a very divergent manner, when they will be so prolonged that they will meet exactly on the retina. A glance at Fig. 11, which illustrates the relative

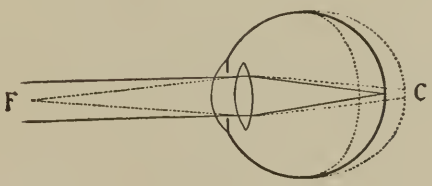


Fig. 11.

shape of the eyeball in a state of normal refraction as shown by the black line, and also its shape in hypermetropia as represented by the inner dotted line and in myopia by the outer dotted line, will also illustrate the reason why objects must be brought very near the myopic eye in order to be clearly seen. It will be seen that rays which are exactly focused upon the retina of an eye of the proper length, the emmetropic eye, are not adapted for either the long or short-sighted eye,

and must be made to assume a different direction from that of parallelism by the aid of lenses placed in front of the eye, as shown in Figs. 9 and 10. In Fig. 11, if the rays enter the myopic eye from the point F, they will assume sufficient divergence to enable them to become focused at C, on the retina. In emerging from the eye, also, light-rays passing the same refracting media must come to a point at F. This point therefore, becomes the far point of distinct vision for the near-sighted eye. Beyond this point everything assumes a blurred and indistinct appearance.

The tendency to short-sightedness is usually inherited, the defect running through many generations, but in varying degrees of intensity. This statement does not mean to imply, however, that children are born with short-sighted eyes. In fact, it is a very rare thing to find an infant whose eyes are myopic. On the contrary, hypermetropia, or long sight, is the usual refractive condition of the infantile organs of sight. Myopia begins to show itself anywhere from the fifth to the fifteenth year of the child's life, the time of its appearance and the rapidity of its increase depending upon the extent to which the eyes are used upon near objects. The essential condition in the eye itself, upon which short-sightedness depends, is a soft and yielding condition of the sclerotic, such as is to be found in childhood and youth. As soon, there-

fore, as the child begins to use its eyes upon its books or playthings an effort of accommodation always takes place, and with this effort a contraction of the lateral muscles to converge the eyes and concentrate them upon the object. It is this continuous lateral pressure, brought to bear upon the yielding tunics of the eye, which tends to cause it to bulge backward at the posterior pole where no resistance is offered. It is thus that myopia is first instituted, and by continuous use of the eyes, especially upon fine work, or by continuous study, it may be with insufficient light, the constant pressure and strain keep elongating the eyeball until a state of excessive myopia is induced, to which also may be added, by the consequent thinning of the tissues at the back of the eye, a diseased condition which may result in blindness sooner or later.

Through the investigations of Professor Cohn of Breslau, in Germany, who was the first to examine the eyes of school-children to ascertain, if possible, the cause of their near-sightedness, some very interesting developments were made, which, through confirmation by numerous observers since, have thrown a flood of light upon the origin and perpetuity of this affection. Out of 10,060 children whose eyes he examined 1,004 were found myopic. He found, also, that myopia increased steadily, both as to the number of cases and as to the degree of the defect, from the

primary classes upward through all the grades. This fact has been abundantly substantiated, by more recent observers, to exist not only in Germany but also in America, and, in fact, the world over. Recent investigations have revealed the fact, also, that in school-rooms which are poorly lighted and badly constructed as to the desks the condition exists to a far greater extent than in such rooms as are thoroughly lighted and better constructed. The effort made to see the work clearly in a dim light and the necessary approximation of the eyes to the book induce, also, a stooping of the shoulders, which attitude is most favorable to an obstruction of the return of the venous blood to the heart, and passive congestions about the head and eyes is the result, out of which may grow other and more serious ailments.

It has been said that myopia is usually an inherited condition. There are some notable exceptions to this rule, among which may be mentioned debilitating diseases and opacities in the visual apparatus causing so poor sight that objects are brought very near to the eye in order to be seen. Myopia has also been developed during middle life from conditions which have served to produce unusual eye-strain. The great intellectual advancement of the present day makes prodigious demands upon the eyes in order that one may be able to keep pace with its progress. Students and literary people are the

ones most affected; dwellers in cities rather than country people; and professional people rather than those that do manual labor only.

There are certain popular fallacies concerning myopic eyes which should receive a speedy and emphatic correction. Among others, there is a wide-spread notion that near-sighted eyes are stronger and more enduring than others. This is a dangerous delusion, and probably grows out of the fact that people who are moderately near-sighted can defer the adoption of glasses for near work until very late in life, say until fifty-five, sixty, and even seventy years of age. The reason for this will be readily understood when one remembers that the far point of distinct vision in the myopic eye is quite close to the eye, and that age does not affect the far point; hence, the effect of age upon a short-sighted eye will be simply the prevention of clear vision as near to the eye as in youth, but still will not carry it beyond its far point.

Again, the processes which tend to elongate the eyeball cause also a liability in the tissues so acted upon to diseased conditions. The delicate choroid and retina, in attempting to follow the distended sclerotic, become seriously injured by the strain put upon them, and not unfrequently either one or both of these membranes becomes detached from its adjoining membrane and sight is destroyed. The vitreous humor also undergoes disorganization, sight fails

rapidly, while masses of dark bodies float about before the eyes. Not unfrequently the choroid becomes the seat of disease which sooner or later may prove fatal to sight. In short, myopia, when of a high degree, is anything but a trivial affection, and the most careful and skilful management is not always successful in warding off the evils which are liable to occur, as penalties of such an abnormal condition.

When myopia has once become established the necessity for accommodative effort ceases, and this in its turn has a tendency to relax the convergence, or the convergence cannot be used independently of the accommodative effort, and so the myope finds himself using but one eye. The result of this is that the eye used the least will begin to deviate outward and divergent squint is produced.

In view of the fact that myopia is a condition of the eye which predisposes it to so many ills, the importance of a pretty correct knowledge of the cause and means of prevention of this affection cannot be too forcibly impressed upon those who assume the responsibility of educating the young. Not only in Germany, but in our own country, within the last two decades, myopia has rapidly increased. With a strong and growing sentiment toward general hygienic improvements and athletic exercises in all grades of school life, together with

better-lighted rooms and more sensibly constructed forms, there is now every reason to hope for a change toward the better in the myopia of school-children.

The remedy for an established myopia is the properly adjusted concave glass. To deny the sufferer from myopia this sovereign remedy is to deny him the pleasures of actual sight. To a person whose farthest point of clear vision is only a few feet away, the prescribing of proper glasses is like opening the doors into realms of light and beauty such as he never beheld before. The necessity, in an educational point of view alone, of giving the youth a clear view of his surroundings, is one of the greatest importance to him; for in order to properly understand this life it is necessary to see that which comprises it and upon which its enjoyments depend. The necessity for the proper adaptation of the spectacles for myopic eyes cannot be too strongly urged. The universal method of selecting from the jeweller's counter, or of being supplied by the itinerant spectacle-vender, should receive a most emphatic condemnation. No person, unless thoroughly versed in the diseases of the eye, should be trusted with such a delicate task as prescribing glasses for the myope, as much permanent injury is liable to be the result.

One of the principal objects to be attained in the prescribing of glasses for the young myope is that he may be enabled to read or write at the usual distance

of persons with normal eyes. In fact, the importance of doing away with an habitually stooping posture is second only to the importance of doing away with over-convergence, as the stooping position not only causes passive congestion about the head and eyes, but also contracts the chest, cripples the heart's action and produces deformity. The proper management of children while at their studies in school should include a prohibition of the child's employing his eyes at a less distance from the book than about fourteen inches. If he cannot see the ordinary type at that distance he should be made to consult an oculist, in order that the proper aid to his imperfect vision be rendered.

Astigmatism is that condition of the eye in which exists an unsymmetrical curvature of the cornea, one meridian having a greater curve than its opposite, so that rays of light passing through each receive a different focus. In the normally formed eye the cornea is very nearly symmetrical in curvature, — i. e., represents a section of a sphere, — in which case, rays passing through any of its meridians are brought to the same focal distance, thus producing a symmetrical and clearly defined impression upon the retina, of all the parts of an object looked at. In the astigmatic eye, rays passing through one meridian of the cornea may be exactly focused upon the retina, while those passing the meridian at right angles to the first may be either focused before they reach the retina, which

constitutes simple myopic astigmatism, or they may reach the retina before approaching a focus, which would then be called simple hypermetropic astigmatism. There is also a condition of general myopia or hypermetropia, with one meridian more myopic or hypermetropic than its opposite, as the case may be, which is termed compound astigmatism. A condition may exist, also, in which one meridian may be hypermetropic and its opposite myopic, which is termed mixed astigmatism. As a rule, the vertical meridian of the cornea is more curved, and therefore has a shorter focal distance, than the horizontal. This is probably brought about by the pressure of the lids upon the cornea above and below. This position of the principal meridians is not, however, always present, for they are found at all conceivable degrees from the horizontal.

The effect of astigmatism upon the acuteness of vision is often considerable. An astigmatic person cannot see objects clearly near at hand or at a distance. In childhood and youth the flexibility of the crystalline lens and the muscles of accommodation overcome the defect to a certain extent, but as youth passes it becomes quite troublesome to see clearly with ease, and the eyes become painful and weak. When, therefore, the sufferer attempts to procure glasses for himself, to enable him to see better, he finds, to his disappointment, that glasses either for

near sight or for far sight afford but little relief. The reason for this is that although ordinary spherical glasses may correct one meridian of the refractive error they do not the others, and the strain is simply shifted in location and but slightly, if at all, changed in degree.

The proper treatment of astigmatism requires the adapting of such a glass to the eye as shall correct each meridian of refractive error. The tests for this condition of the eye are made in a general way by looking at a card, placed at the usual distance for the test letters, with lines radiating in all directions from the centre. The astigmatic eye will see certain of these lines much clearer than those running at right angles to them. In order to enable the eye to see all the radiating lines with equal clearness a glass, it may be, which consists of but one curved axis, the other being plain, is required; or, if hypermetropia or myopia are also present, one surface of the glass must be so ground, equally curved in all directions, as to correct this, while the opposite side of the glass is ground with one of its meridians curved and the other plain, to correct the astigmatism. The proper adjustment of such glasses requires, as in myopia, the skill of the oculist, who not only understands the proper method of correction, but also, from his intimate knowledge of the effect of such conditions upon the eye, is thus enabled to know just when, and under

what circumstances, and just how much and how little, to apply the remedy.

Presbyopia, or old sight, is a term used to designate a condition of the eyes which is the natural result of advancing years, and which is characterized by a tendency to hold the book in reading, or whatever is desired to be seen clearly, farther away from the eyes than formerly. The reason of this lies in the fact that as one grows older the crystalline lens becomes denser and firmer and less elastic year by year, and is therefore increasingly less easily acted upon by the ciliary muscle. At ten years of age the child has sufficient accommodation of the eyes to enable him to see small objects clearly at from two and a half to three inches distant, but from this time onward to old age there is a steady increase in the firmness of the crystalline lens, as well as, a little later in life, a less ready action of the ciliary muscle.

The peculiar power of adjustment possessed by the eye, to enable it to see both near and distant objects, received the name of accommodation long before the mechanism by which the act was effected was understood. Before the investigations of Donders and of Cramer, who ascertained that the accommodation of the eyes was effected through an increase in the convexity of the lens and a consequent increase in its refractive power, much confusion prevailed, and various theories were advanced to account for this adapta-

bility of the eye to varying distances. Investigation soon revealed the method by which the crystalline lens was made to change its convexity, and the part played in that process by the muscle, which, forming a part of the ciliary body, surrounds the lens, and by its contracting relaxes the suspensory ligament which holds the lens in position, allowing it, by its inherent elasticity, to assume a more convex shape.

Presbyopia, or old sight, being due, then, to a partial loss of power in the crystalline lens to change its form, must be the common lot of all at a period varying from the fortieth to the fiftieth year of life. At least, this is the age when the individual becomes cognizant of a weariness and strain in the eyes when they are applied to near objects, although the designation of a certain age at which this infirmity begins is somewhat arbitrary. The above conditions refer to emmetropic eyes, or those in which no refractive error exists. If myopia should be present, the adoption of spectacles for near work will necessarily be postponed to a later period of life, depending, of course, upon the degree of near sight. It is the boast of some people beyond fifty or fifty-five years of age that they never humor their eyes to use them to glasses. The fact that they do not wear glasses for near work is simply owing to a condition of near-sightedness of which they are undoubtedly ignorant. A test of their distant vision will prove such to be the

fact. Again, people suffering from hypermetropia, when of so slight a degree as not to require the wearing of glasses during the earlier years of life, begin to suffer from eye-strain and many of the symptoms of presbyopia comparatively early in life, and are driven to the necessity of putting on glasses at so early an age that they often become frightened at this supposed suggestion of a premature old age.

Now and then aged people, who have perhaps been obliged to wear glasses for thirty or forty years, suddenly become conscious that they can see to read better without the glasses which have heretofore been indispensable, — an apparent return of youthful vision sometimes called the "second sight." This apparent phenomenon, so puzzling and yet so pleasing to the participant, is usually brought about through the effect upon vision of a very small pupil, which is a result of age, and a softening of the substance of the crystalline lens, allowing it to assume a greater convexity, — a condition which is often the ushering in of a cataractous condition of the lens. It may also occur through a general softening of the tunics of the eye, allowing the pressure of the lateral muscles to produce an elongation of the eyeball, thus rendering it myopic.

A word of caution and encouragement will not come amiss just here, in regard to the use of spectacles. The writer has so often encountered, and has

deen so often obliged to spend much valuable time in controverting, a wide-spread, popular prejudice against putting on glasses just as long as the eyes could be made to endure the strain without, that a candidly expressed refutation of such an error may be the means of doing much good.

It is not an uncommon, but nevertheless painful sight from the oculist's point of view, at least, to witness people struggling with their newspaper held at arm's length, painfully endeavoring to read its columns. Such people, as a general thing, think they are doing their eyes a favor by putting upon them all this strain, and keeping glasses away from them as long as possible. They say if glasses are once used they must always be used, for "the eyes get so accustomed to them that they cannot get along without them." Now if this unfortunate notion were confined wholly to the ignorant classes of people, so called, there might, perhaps, be more excuse for saying nothing about it; but as there are so many who, from an educational point of view, should be better informed in regard to the physiology of the eye than to entertain such a fallacy, I wish to say that when the eyes become troublesome as to sight, and the trial of glasses, under the direction of a competent oculist, proves a source of relief, have no fear that you will be doing the eyes an injury by putting them on and wearing them constantly, or as need requires. If,

after wearing the glasses a day or two, you find the eyes without them do not see as well as formerly, but with them are all right, have no fear that the glasses are injuring the eyes, — they are actually doing them good; and the reason that vision without the glasses is apparently not so good as before putting them on is simply this: the eye-strain is passing away and the eyes are happily adapting themselves to the luxury of the boon you have conferred upon them. You would not naturally expect them to exist under the same condition of a highly strained accommodative effort after that effort had been dispensed with. The failing power of the accommodation to render the crystalline lens more convex requires the supplementary use of a convex glass in front of the eye. Allow me to say that the proper strength of this lens is of great importance, and no unskilful hand should adapt it. The object of the glass is simply, but exactly, to add to the crystalline lens the focusing power necessary, while taking into account the strength of the accommodative effort required and the temperament and occupation of the individual.

Asthenopia, sometimes designated as weak sight, is a term somewhat broad in its meaning, and is commonly used in connection with a number of qualifying adjectives as descriptive of the location and nature of the causative conditions. In its broad sense it is applied to that condition of the eyes in which they are

incapacitated for much use, especially in the act of accommodation, on account of pain and other uncomfortable sensations. It may be the result of an uncorrected myopia or hypermetropia or astigmatism, the two latter conditions being more frequently the cause. When the eyes are much used, with a refractive error uncorrected by the proper glasses, it is most natural for pain and dimness of sight to follow. The proper remedy and the effectual cure for such a cause is obviously the wearing of the glasses which correct the refraction. Asthenopia is sometimes dependent upon a faulty or insufficient action of the muscular appurtenances of the eye, affecting either the accommodation or the proper balancing and harmonious action of the long muscles. When such defects exist they often present a very puzzling problem for solution, as the correction of a defect in one muscle will sometimes make more manifest that in another, and the skill and patience of the oculist is often taxed to the utmost. Modern science has, however, shed much light upon the obscure causes of eye-pain and weakness of sight, and the sufferer from these affections can now look with a great degree of confidence for much or entire relief; while the victims of asthenopia of less than half a century ago were often doomed to a bitterness of life quite unendurable, for in many cases the giving up of cherished plans of study, or of congenial occupations, was enforced upon them, and

they were often sent from home on long sea-voyages, in the vain hope that change and cessation from using the eyes would restore them again to a condition of painless usefulness.

Some modern ophthalmologists have gone so far as to assert that various nervous diseases, such as chorea, epilepsy, sick-headaches, and the like, have their dependence upon an unconcerted action of the eye muscles, and can, in the majority of cases, be cured by restoring to their proper balance these muscles of the eyeball by a slight operative procedure, which consists in making a partial or total separation of their tendonous attachment to the eyeball. However absurd such an assumption may seem to be in the full sweep of its significance, there is no doubt whatever but that a weak condition of the eye muscles is the cause of quite a train of nervous affections, and the fact is beyond dispute that many cases of distressing headache, as well as of nervous irritability, have been relieved by a slight operative procedure upon one or more of these muscles.

In those cases where no muscular or accommodative defect is present, and where no refractive error is to be found, there is often discovered a peculiar sensitiveness of the retina to light, — an irritable state of the terminal elements of the optic nerve; or the sensibility of the retina becomes quickly exhausted, and an object looked at for a short time seems to fade

away. In fact, the vagaries as to form and importance of the eye-conditions which are classed under the one comprehensive term asthenopia often render a most exacting examination of the eyes necessary, and call for the utmost skill in the application of the remedy.

As one of the results of defective sight, commonly due to an excessive degree of refractive error, there is sometimes produced a deviation of one eye from a state of parallelism with its fellow, called *strabismus* or *squint*. The most common form is that in which one eye "turns in." It commonly occurs in childhood, and at that age when the child commences to use his eyes upon his toys, picture-books, etc. At first it seems to be present only once in a while, but very soon becomes permanent, the child at first using indifferently one eye then the other. Very soon, however, but one eye, the best-seeing one, is used constantly, while the other is left to itself. This condition of the eye is produced by the strong tax made upon the muscles of accommodation and convergence in order to overcome the refractive error (usually hypermetropia) sufficiently to see clearly. This effort causes spasmodic contraction of the internal recti muscles, and finally a permanent state of contraction ensues. The origin of squint is often supposed to be due to an attack of sickness, as measles, scarlatina, hooping-cough and convulsions. When it occurs after

such attacks it is probably due to the debilitating effect upon the system which has precipitated a state of things which was imminent before. At the commencement and during the early stages of squint if the suitable glasses were adapted to the child's eyes the defect could quickly be overcome. For obvious reasons it would be found a difficult task to induce a young child to take kindly to glasses. It is well, however, by different devices to induce the child to use either eye, — sometimes one, sometimes the other. In that way the faculty of seeing will not be lost in the deviating eye, as it inevitably would be, sooner or later, if left entirely to itself. As soon as the child gets old enough to wear glasses they should be given him, and if the squint is not relieved in a few months operative interference may be called for, and at the same time the proper glasses prescribed for constant wear.

Another condition of the eye muscles, characterized by an inability to use the eyes at varying distances without pain, is known as weakness of the accommodation. This is seldom a disease *per se*, but is the result of some debilitating disease or blood-poisoning. This is a quite common sequel of diphtheria, and is shown by the patient not being able to see to read, while distant vision is nearly or quite as good as formerly. It is the result of a loss of power in the ciliary muscle, which loss of power is also manifest through-

out the muscular system generally. This state of things is often a source of great anxiety to the sufferer, for he fears his sight is leaving him. As the strength returns, however, so will the muscular sufficiency. It is often, after some debilitating sickness during which the muscular system is relaxed, that a condition of strain or tension in the ciliary muscle, which has heretofore concealed a hypermetropia or astigmatism, giving way, reveals the fact that the eyes require to be supplied with spectacles.

Paralysis of one or more of the eye muscles is liable to occur. For instance, if the external rectus should become paralyzed, the eye would turn inward, and it would be impossible to turn it outward beyond the median line. If the internal rectus were to suffer paralysis, other muscles, also, which are supplied by the third nerve, would probably be paralyzed; so that, beside the turning outward of the eye, the pupil would also become much enlarged.

CHAPTER V.

SPECTACLES — THEIR USE AND ABUSE.

SPECTACLES have, without doubt, been more or less in use for many hundreds of years. The Chinese, who claim to have originated many things long before we had either history or tradition, claim to have been the inventors and first users of these important aids in many of the abnormal conditions of the eyes. Whether or not such was the case the first names of which we have any authentic account associated with the origin of spectacles are those of Roger Bacon in England, who died about the year 1292, or of Salvinus Amatus, a Florentine, whose death occurred in 1317 and upon whose tombstone is inscribed, "The inventor of spectacles."

The original use of spectacles was for the protection which they afforded the eye against the invasion of foreign bodies. Then the coloring of the glass came into vogue, by which to modify the effect of light. Finally, the adaptation of convex or concave

glasses, which arbitrarily and but approximately relieved refractive defects and rendered some slight relief to the eyes. At length, after the researches of Donders in the field of ocular refraction, the more appropriate use and better adaptation of spectacles to the refractive conditions of the eye has led up to a science which, to-day, can boast of some perfection.

The simplest form of spectacles is to be found in those which are used only for the protection of the eyes, and may be either plain, white glass, or, if it is desired to modify the light to sensitive or diseased eyes, those having some neutralizing color. Formerly green glasses were much used for this purpose, but modern investigation has proved this color injurious in many cases and they are now discarded. A tint of blue affords much relief when using the eyes by artificial light, but for a general modifying effect of white or sunlight the London smoke glasses of varying tints are now generally adopted, as they do not decompose the light passing through them, only rendering it less intense. The size and shape of these glasses must vary according to the needs of the given case. Ordinarily a medium shade should be selected, and the eyes should be large and perfectly clear and true. Colored glasses should seldom be worn in the house, and of course not at all unless their use is demanded by certain abnormal conditions of the eyes. In selecting protective glasses of this

kind great care should be exercised in choosing those which are even and free from flaws of any kind. The cheaper grades are often more productive of harm than of good, as they tax the eyes by distorting the shape of objects looked at, whereby a condition in the eye is induced, while using them, similar to an irregular astigmatism, and producing the same effects upon the eyes as this refractive error would do if uncorrected. In order to determine whether a glass is free from this defect, hold it at a little distance from the eye and look through it at a window or other object having straight and parallel sides; then, by moving it quickly from side to side and up and down, if the glass is free from defect the outlines of the object looked at will not be changed.

The use of colored protective spectacles is an indispensable boon to travellers over sandy deserts, or in regions of snow and ice, when the glare of the sunlight produces such an irritating effect upon the retina as often to cause blindness. The races of people living in the extreme north suffer much from the effect of the continuous reflection of the sun from the snow, for a period of four months, which constitutes their day.

The spectacles which are generally used for the purpose of correcting some optical defect are either spherical concave, spherical convex, or cylindrical or a combination of spherical and cylindrical. They

are made of crown or flint glass, and of Brazilian quartz, commonly known as "pebbles." As to the relative advantages of these different materials a few words will suffice. The best material, and that which is almost invariably used by the leading manufacturers, is flint glass, as it is uniform in its refracting qualities when properly made, and is sufficiently hard for practical purposes. Crown glass is also good, but softer and more liable to become scratched. Pebbles are, perhaps, better when a hard surface is desired, but they are sometimes harmful to the eyes on account of an uneven refraction due to a varying density of the material, and have but few, if any, advantages over good flint glass. The essential qualities of a glass are perfect clearness, uniform density and exact grinding, — qualities found only in glass of the best quality.

Spectacle-glasses may be ground with both surfaces convex — called double convex, or both surfaces concave — called double concave; but the more usual method of grinding glasses at the present time is with one surface — the outer — convex, and the inner surface concave. To such glasses are given the name periscopic. They have some advantage, if carefully ground, on account of a less distortion of the images when the rays pass through them obliquely, than is the case with glasses where the two surfaces are ground the same. Then the eyes may be more freely moved

without the necessity of turning the head also, which has to be done with the ordinary glasses in order to see the best.

Fig. 12 shows the different forms of the glasses just mentioned.

Then we have glasses ground for the purpose of

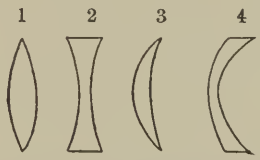


Fig. 12. — 1, Biconvex; 2, Biconcave; 3, Periscopic convex; 4, Periscopic concave.

accomplishing certain objects. Prismatic glasses are often prescribed for their effect in relieving certain of the eye muscles from undue strain, or to render binocular vision easier when one eye has a tendency to

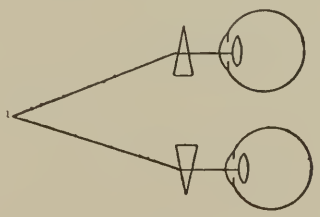


Fig. 13.

deviate from exact parallelism with its fellow eye. Sometimes, in weakness of the internal recti muscles, causing great pain in attempting to use the eyes on

close work (muscular asthenopia), the wearing of prisms of the proper strength to overcome the strain, with their bases turned inward, is a source of very great relief. The principle upon which they work is shown in Fig. 13, which illustrates the bending of light rays toward the bases of the prisms, rendering divergent rays parallel and enabling binocular vision without the eyes being converged.

Cylindric glasses have a curvature of surface in one meridian only, and are intended to correct but one meridian of refractive error in the eye. The name cylindric is given them from the fact that they represent a section of a cylinder of glass thus:

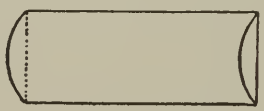


Fig. 14.

When people arrive at the age when it becomes necessary to wear glasses for near work, if they are myopic or hypermetropic it is very convenient, and often desirable, to have spectacles arranged so that the upper portion of the glass shall correct the refractive error, while the lower portion shall possess that strength sufficient to enable them to see near by with ease. Glasses so made as to accomplish this object are called bifocal or pantoscopic. They may either

be composed of two separate pieces carefully joined together, or the different curvatures of surface necessary can be ground upon the upper and lower portions of the same glass. Such glasses, where they can be well worn, obviate the necessity of using two pairs of spectacles and are a real convenience.

Spectacle lenses are mounted in frames of gold, silver, steel and celluloid. One kind has no especial advantage over another, except as to cost and the taste of the wearer. Whether spectacles or nose-glasses are best in a given case will depend upon a variety of circumstances. If one has to wear them all of the time there is no doubt as to the superiority of spectacles; but in those cases where it is necessary to wear them only at short intervals the nose-glasses are the most convenient, and no real objection can be raised against their use in such cases, provided there is no astigmatism to require correction and the centres of the lenses are exactly in front of the pupils. The question which is sometimes raised as to the injurious effect of the pressure upon the side of the nose produced by nose-glasses is one which can be answered only by taking into account the peculiarities of each individual case.

The proper shape, size and centering of spectacle lenses is a matter of very great importance. The centre of the lens should be in the direct line of vision: if for long range, they should be adapted with the eyes

in that position; if for close work, the convergence of the eyes should be considered and the centres brought nearer together. The proper kind and height of nose piece, as well as the proper distance of the glass from the eye, are all matters of no inconsiderable consequence in the careful and right adaptation of the spectacles.

The effect produced upon the eyes by the wearing of glasses requires consideration here. It is frequently the case that glasses which correct the refractive error are not well borne at first. In cases of high degrees of hypermetropia or of astigmatism, which have been endured for years uncorrected, thereby producing great strain upon the muscles of accommodation, it will sometimes require a little time and the exercise of considerable patience before the eyes will adjust themselves so as to be comfortable under the new arrangement. In some cases a full correction of the refractive error can only be effected by a gradual approach to it, through the wearing of weak glasses at first, which should be gradually increased to the proper strength. The first wearing of cylindric glasses, especially if the axis of the cylinder is placed obliquely, will sometimes produce an apparent unevenness of surfaces, an effect due to an as yet unrelaxed spasmodic contraction of the ciliary muscle. Other unpleasant effects are also experienced at first, such as would result from a change in the apparent size of objects and in the estimate of

distances. The above remarks must not be construed to mean that persons in selecting glasses for themselves, even if they should not happen to obtain the glasses that are perfectly easy at first, should persevere in the wearing of them until they do become so. Nothing in these talks about the eyes can possibly be construed into an intimation that a person suffering from any real defect of sight should ever undertake to fit glasses to his own eyes, or entrust that fitting to one who is not thoroughly conversant with all the phases of refraction.

CHAPTER VI.

DISEASES OF THE EYES OF COMMON OCCURRENCE.

CERTAIN diseases of the eyes demand consideration in connection with the knowledge which this little work is designed to impart, which, on account of their frequency and their apparent simplicity, are either left entirely to themselves or are so improperly treated as often to result in permanent injury to the eyes. Some very important and dangerous affections of the organs of vision have their origin in a very obscure and apparently harmless manner. Even a trivial inflammation or a slightly painful condition has the possibility, under certain circumstances, of being the beginning of a most serious and destructive disease. This does not apply, however, to a large number of the most common abnormal conditions. Yet the fact is just as pertinent that a proper understanding of the nature of the trouble and a somewhat intelligent application of remedial measures should be carried out. This can, of course, the more effectually be accom-

plished the better knowledge we have of the diseased conditions.

The most common, and, under ordinary circumstances, the least harmful, disease to which the eyes are liable is simple conjunctivitis, or inflammation of the membrane lining the eyelids and covering the front of the eyeball. It may be caused by irritating substances in the atmosphere, like dust, smoke, etc., and is of frequent occurrence in the spring of the year, appearing sometimes as an epidemic. It may occur as the result of an acute catarrh or cold in the head, then taking the name of catarrhal conjunctivitis. It is a condition which will disappear with the removal of the cause, and requires but little treatment *per se.* Should it persist, it might result in follicular inflammation, or even go on to the stage of granular conjunctivitis, in which condition it might be very difficult to remove it, even if it did not produce much haziness of vision from opacity of the cornea induced by the constant friction of the rough surface of the granular lids over the delicate corneal tissue. A persistent conjunctivitis is a frequent result of an uncorrected refractive error. In such a case the only cure is the wearing of properly fitted spectacles.

A greater intensity of conjunctival inflammation often results in the purulent form, and then becomes a source of much danger to the eye. Purulent ophthalmia is especially liable to attack the eyes of

young infants, and is then known as infantile ophthalmia. This condition requires prompt and careful treatment, as delay or improper management is quite apt to result in permanent loss of sight. The secretions from an eye affected with purulent ophthalmia are infectious in the extreme, and the greatest care should always be observed to prevent the secretion from being conveyed to other eyes through the use of a common towel or other toilet articles, or by carelessness in not destroying all cloths and sponges used about such eyes. Most alarming epidemics of purulent ophthalmia have occurred in asylums and schools where children have been crowded together and the sanitary conditions were not carefully superintended. All statistical reports of cases of blindness show that the destructive purulent inflammations of childhood have been, more frequently than any other form of eye disease, the causes of such blindness.

Purulent ophthalmia is one of those diseases which will admit of no delay in the application of proper methods for its relief. Many eyes have been hopelessly lost by the delay of only a few hours, especially in debilitated constitutions and infants. Its onset is often rapid, and its destructive tendencies, by causing ulceration and destruction of the corneal tissue, are merciless. All conjunctival inflammations, if continuous and unchecked, show a

tendency, sooner or later, to affect contiguous tissues.

The eruptive diseases, such as measles, scarlet-fever, small-pox, etc., as well as certain skin diseases, show a strong tendency to affect the conjunctiva. In diphtheria, also, there sometimes occurs a membranous deposit upon the conjunctiva, which places the eye in great danger unless carefully treated.

Next to the frequency with which conjunctival diseases occur are those of the cornea. The onset of a corneal affection, whether it be a general inflammation of its tissue or a localized spot, as a vesicle or ulcer, is characterized usually by great intolerance of light and sometimes much pain. A slight haziness of the transparent cornea is sufficient to give rise to much indistinctness of vision, and for this reason, if for no other, the sufferer becomes anxious as to his condition. Inflammations and ulcerations of the cornea are more liable to occur in scrofulous children, and are a source of real danger to the sight. The existence of an ulcer directly over the sight is to be deplored, as after its healing there is quite sure to remain a white opacity which may never entirely disappear. Much time and a great deal of patience are often required in the management of these cases and the patient should never neglect them. Their occurrence is liable to be repeated over and over again until adult life, when they generally cease to annoy.

The greatest danger to be apprehended from ulceration of the cornea is that it may extend so deeply as to perforate through it, causing the aqueous humor to flow off and allow the iris to become entangled in the wound, from which it cannot be freed except by operation, and of necessity producing a permanently irritable eye.

Lying as the iris does just behind the cornea, and becoming almost contiguous to it at its outer border, we would naturally expect a severe affection of one of these tissues to extend to the other. And such is indeed often the case, although each one may be the seat of idiopathic inflammation confined to its own ground. Inflammation of the iris, termed iritis, is very liable to be overlooked in its early stage and regarded as an affection of the conjunctiva only, as conjunctivitis is almost invariably an accompaniment of iritis. The intensity of the pain in affections of the iris, especially more severe at night, and the haziness of vision, should always suggest something of a more severe character than simple conjunctivitis, and put the sufferer on his guard.

Iritis is a dangerous affection of the eye if not early recognized and properly treated. The iris is not only liable to become firmly bound down by adhesions to the capsule of the lens, and the pupil to become filled up with inflammatory products, but the inflammation may extend to the ciliary region, and also to

the choroid, involving the eyes in a long, painful, and exceedingly dangerous affection. The treatment of this affection should never be neglected nor undertaken by unskilled hands.

The presence of severe pain in the eye should always awaken suspicion of some deeply seated trouble and send the sufferer to a competent physician, who, by his timely recognition of the nature and location of the disease, and the application of the proper treatment, may save long weeks of suffering and perhaps eventual blindness.

Among the diseases of the eye whose onset is very liable to be overlooked, on account of the insidiousness of its approach and a lack of definite symptoms, is glaucoma. This is an affection of the eye seldom occurring before the middle period of life, but one, nevertheless, from which a large amount of blindness has resulted. It sometimes comes on suddenly and runs its course quickly, with great pain and rapid loss of sight. In other cases its presence may only be suspected by occasional attacks of dimness of sight, accompanied or not by pain and quickly passing away; a like process to be again repeated, sooner or later, but with less rapid and complete recovery. It is caused by an excess of the fluids of the eye, retained on account of an obstruction in the natural channels for their outflow. The eyeball becomes tense and hard, the pupil dilated and the cornea somewhat hazy.

Many an unfortunate sufferer from this disease of the eye has been allowed to become permanently blind on account of a lack of recognition of the disease by physicians unskilled in the diseases of the eye. A large proportion of cases with this disease can be relieved if timely aid is brought to bear before sight is much impaired. The cure lies in the making of a slight operation upon the iris, called iridectomy.

Affections of the optic nerve and retina can only be suspected by the sufferer on account of the presence of pain and dimness of sight. The retina is not unfrequently the seat of diseases brought about by a variety of causes. It may become inflamed, as from over-use of the eyes, or the subjecting of them to the influence of bright and continuous light, such, for instance, as the reflection of the sun from desert sands or snowy wastes. Snow-blindness is produced by the disturbance of certain elements of the retina by the bright glare of white light. This tissue may also become diseased from inherited conditions. As an example of this, the affection known as "*retinitis pigmentosa*" is one of the most interesting, as well as unpleasant in its results. It is recognized, by aid of the ophthalmoscope, as presenting a picture of black spots of excessive pigmentation scattered all over the fundus of the eye. Victims of this affection are always troubled about seeing as soon as night comes on. They see very well in the daytime, but

after the sun sets they are comparatively helpless. This symptom gives rise to the name of "night-blindness." It was formerly supposed that this was a special result of consanguineous marriages, and is so stated by the older authorities. Modern investigation has rendered this cause a somewhat doubtful one, and has also thrown some light upon methods for the relief of the malady in many cases where formerly it was supposed to be incurable.

The retina often becomes affected as a result of some form of kidney disease. In certain cases of Bright's disease the first symptom to arrest the attention of the sufferer may be an unaccountable dimness of vision, which the oculist, by the aid of the ophthalmoscope, is able to refer to the kidneys, by the condition of the background of the eye, as unerringly as the subsequent analysis of the secretions from the kidneys may prove confirmatory. Diabetes may produce a similar effect upon the retina, characterized by more or less hemorrhage from the rupture of diseased bloodvessels. Diseases of the retina may, and in course of time very frequently do, extend to the choroid, in which case the eye may become destroyed.

Popular ideas regarding the nerves of the eye, and especially the optic nerve, or nerve of sight, are various and often ludicrous. Many people present the diagnosis of their own case, on coming to the physician, by the assertion that they have "strained

the nerve of the eye" by hard or careless usage. It is very true that one may use the eyes excessively, and thereby do them much harm, but the "straining of the nerve" is a vague and meaningless expression. The optic nerve may become the seat of disease induced either by bad habits or from the existence of a brain lesion, or from disease of its own structure. The excessive use of tobacco and alcohol affects all the nerves in a varying degree, but the nerve of sight is affected in a special manner. It may first become congested through the agency of the poison, in which condition the sight becomes very poor, and especially in the line of direct vision. It becomes impossible to designate colors, — red and green, for instance, appearing the same. If the cause is kept up the trouble goes on until complete atrophy of the nerve ensues and sight becomes permanently lost.

Atrophy of the optic nerve may take place without any known cause, and the sufferer be doomed to irremediable blindness; for when the optic nerve takes on a condition of progressive atrophy there is no known help for it. Affections of the optic nerve may also cause the loss of a portion only of the field of vision, the line of demarkation being either vertical (vertical diplopia) or horizontal (horizontal diplopia). Atrophy of the optic nerve is occasionally found in infancy, when the aimless movements of the eyes first attract the notice of the mother or friends,

and the tests applied only confirm the fears as to the hopelessness of the child's condition. Such a condition in infancy or childhood is almost invariably a result of heredity, and furnishes a fruitful theme for the speculative philanthropic restrictions of the marriage right.

People are often annoyed by the presence before their sight of floating specks and masses (*muscæ volitantes*). They are frequently a source of much anxiety, especially when noticed for the first time. They occur also in a debilitated state of the system, and are not significant of disease in the eyes unless quite numerous and large, when the ophthalmoscope shows them clearly, with just their location in the vitreous humor, and also the cause of their production can be quite definitely substantiated.

The crystalline lens may become opaque through injury to the eye, or as the result of age rendering the sight dim, and in cases of mature cataract inducing blindness by obstructing the passage of light into the eye. Cataract is an opaque condition of the lens, and its seat is, of course, just behind the pupil, where a whitish or grayish substance presents itself instead of the normally black pupil, and is not the whitish or grayish condition of the cornea which results from severe inflammation of that tissue. The removal of cataract consists in the extraction from the eye of the diseased crystalline lens. The wearing of strong con-

vex glasses after cataract operations is to furnish a substitute for the lost crystalline lens, so that light-rays may become focused upon the retina.

The eyelids are frequently the seat of disease, either originating in their own substance, or existing as the result of constitutional dyscrasiæ, or having their dependence upon errors of refraction. The frequent occurrence of small abscesses near the edges of the lids, popularly designated as styes, is generally due to a constitutional derangement; but their frequent occurrence may be induced by an over-use of the eyes (especially if hypermetropia is present), exposure to cold, damp winds, and derangements of the digestive organs. The relief from these annoying and painful local inflammations is to be sought in constitutional treatment, or treatment appropriate to the cause, primarily; but the inflammatory stage is best treated by soothing lotions or fomentations of hot water, until suppuration develops, when an incision sufficient to thoroughly evacuate the pus should be made. Styes frequently occur in rapid succession, one after the other, until some constitutional change takes place, when they cease for a while.

Ulceration of the margins of the lids (Blepharitis ciliaris) is a not unfrequent occurrence in scrofulous children, and is usually associated with phlyctenular inflammation or ulceration of the cornea. When persistent, and especially in young and middle-aged

persons, I am led to suspect faulty vision as the foundation of the difficulty, and examine the eyes with reference to the need of glasses, often finding that a correction of the refractive error cures the disease.

Tumors sometimes occur, either in the upper or under lid, and are the result of an obstruction in the minute ducts leading to little glands situated near the lid margin. They may disappear of their own accord, but if they do not their removal is advisable and is easily effected.

An exceedingly annoying affection of the eyes is that in which the tears fail to find their way through the natural channels into the nose, and overflow upon the cheek. The cause of the trouble may be owing to an eversion, or turning outward, away from the eyeball, of the little openings called the *puncta lachrymale*, situated near the inner angle of the eyelids. It is necessary, in order that the tears may be drawn down through the tear passages, that these little openings should be in close contact with the eyeball. If, from disease of the lids causing thickening of their substance, these puncta become separated from close contact with the globe of the eye, the tears will not pass through them as freely as they should. Sometimes the puncta become obstructed and prevent the entrance of the tears. But more frequent than other causes is an obstruction in the nasal duct, resulting

from inflammatory swelling of its lining. This is frequently caused by catarrh of the nasal passages, and very seldom gets well of itself when once established. The damming up of the tears in the lachrymal sac gives rise to inflammation of its lining, and soon the formation of pus adds a new annoyance to the patient's former trouble.

Large and painful abscesses sometimes follow these inflammations of the tear sac. People who regard the welfare of their eyes and those who do not wish to become objects of disgust to others should never neglect these tear-passage troubles until they become incurable. In the early stages the difficulty can be removed by the passage of a small probe several times through the entire length of the lachrymal canal. After the trouble has assumed a chronic form and suppuration of the sac has taken place the stricture in the nasal duct must be removed by a slight operation; then the passing of a probe as many times as is deemed necessary for a cure is called for. The old-fashioned method of wearing a silver tube with its end projecting from the edge of the lower lid is now completely abandoned for the cleaner and more effectual method of probing.

An exceedingly interesting and important defect in the visual perception is the defect known as *color-blindness.* Within the last decade scientific investigation of this important visual peculiarity has

developed many interesting facts which concern not only the subject of the defect personally but also the public generally. The necessity of correct color perception by engineers on our railroads and sailing masters and pilots upon the sea has become a matter of so great importance to the safety of the travelling public that an examination of the eyes of all those who are engaged in such employment is required by the companies employing them. That the safety of those who travel by rail or sea is much enhanced thereby is evidenced by the rarity with which accidents occur at the present day from mistaking red and green lights as compared with former times.

Color-blindness is, in the majority of cases, congenital and very markedly hereditary. Yet it may be caused by disease, either constitutional in character or located in the optic nerve or brain. A portion of the retina may also become color blind by an affection existing in the eye alone. Tobacco and alcohol, excessively used, so as to affect the optic nerve, almost always produce a partial color-blindness, which is usually restored by an abstinence from the cause, but sometimes even after the sight is wholly restored the color perception remains annulled.

The yellow spot of central vision of the retina is that upon which color is most sharply perceived, as well as the form of objects, the outer or peripheral

portion of the retina being incapable of recognizing colors to a varying extent and according to the color. Blue can be recognized over a wider area of the visual field than any color except white. Then comes red, and finally green, which is recognized over a comparatively small area around the central point of vision.

The pathological condition which exists in cases of color-blindness is a matter of theory and discussion; but the most probable, and the one meeting with most general acceptance at the present day, is that deduced from the theory of color perception advanced by Young in 1800 and modified by Professor Helmholtz nearly a half-century later. This theory is briefly as follows: That there exists three sets of fibres in the eye corresponding to the three fundamental colors, and that each of these three colors excites its corresponding nerve fibre and also to a slight degree the other fibres. Accordingly, red would stimulate not only the red fibres, but to a slight extent those of green and violet. If, then, the two latter fibres could be eliminated, a sensation of pure red would result. This is produced by looking at the color formed by the union of green and violet until the fibres corresponding to green and violet become fatigued, which they readily do, and then the complementary red of the after image appears more vivid than the present red with the eye in its natural condition. A like

explanation pertains to the perception of other colors, but it would be out of place to enter into them here. Color-blindness is, then, if the above theory is correct, a deficiency in certain of the fibres, and the amount of the deficiency of color is in proportion to the extent to which each set of fibres enters into the composition of the act of color detection.

The most frequent form of color-blindness is that where red cannot be discovered, and was formerly designated as "Daltonism," from the name of the individual who first noticed this defect in himself and accurately described it. Dalton was an eminent English chemist, and the report which he published of his case excited much interest in the subject, and prompted to investigation in many parts of the English-speaking world.

It is a most interesting fact that a much larger proportion of males are affected with color-blindness than females. No satisfactory explanation of the fact has as yet been given, but from observations made up to the present time, while four or five per cent of men are found to be color blind, only a small fraction of one per cent of women have so far been recorded as deficient in color perception.

Color-blindness is incurable when congenital. No amount of familiarity with colors or training in their detection renders the subject better able to detect color.

CHAPTER VII.

INJURIES OF THE EYE.

The natural position of the organ of vision in its bony stronghold, and protected by the cartilaginous covering included in the composition of the eyelids, renders it comparatively secure from ordinary injury. Extraneous substances, like particles of dust or cinders or pieces of iron, are liable to come in contact with the eye and create a greater or less disturbance according to size and character. Smooth substances will usually be washed out by the increased flow of tears which they excite, but those having sharp points and acute angles may require removal by turning the eyelids outward. The upper eyelid can be easily everted in the following manner: Grasp the eyelashes between the thumb and finger and draw the lid well down and outward, at the same time requesting the party to look well downward toward the floor. Then, with a pencil, or any small, round substance, placed upon the outer side of the lid at the upper edge of the car-

tilage, press downward gently, while the edge of the lid is raised. This exposes the inner surface of the lid, and a foreign body, if lodged there, can be readily seen, and removed by a small fold of the handkerchief. Sometimes, also, drawing the upper lid downward by aid of the lashes so as to cover the lower lid will cause displacement of the foreign body. *Eye-stones* are, as a rule, useless and sometimes harmful. Formerly much faith was placed in their ability to reach and bring out particles of foreign matter. It is true that sometimes a loose foreign substance may adhere to the stone and be brought away, but the days of superstition which believed in a special power which they were thought to possess have happily passed away.

If the foreign body has entered the eye with sufficient force to partially penetrate the outer tissues, or has become lodged upon the cornea, it will create much pain and inflammation, and should be removed as soon as possible. Its removal can be effected without pain after a few drops of cocaine have been instilled into the eye.

Pieces of iron or steel may be driven with such force as to penetrate the coats of the eyeball and lodge in some part of the interior of the eye, and the wound produced by their entrance, if small, might so conceal the actual state of things as to lead to a diagnosis of simple external injury, until, sooner or later, their presence is manifested by deep inflammatory action

and loss of vision. The fact that, in a few cases, foreign bodies have been known to remain imbedded in the inner tissues of the eyeball for many years, without giving rise to serious inflammation, is far from sufficient reason to postpone a thorough investigation of the location of the foreign body by a competent specialist, and, if thought best, suitable attempts for its removal made. If the foreign body cannot be removed from the interior of the eye by means of instruments or the magnet, and especially if the sight of the eye is destroyed, the entire removal of the eye should in many cases be accomplished, lest sympathetic inflammation in the fellow eye be set up, and both eyes become lost. In cases where an injured or diseased eye has been removed, an artificial eye can usually be worn, which in a large number of cases would be very difficult of detection.

Injuries caused by sharp or pointed instruments, such as knives, scissors or sharp pieces of wood entering the eye, are apt to injure the crystalline lens, in which case it will become opaque or cataractous. In children such an injury to the lens causes it (the lens) to become absorbed, but in adults the removal of the lens, as in cataract from other causes, is often required.

Injuries from the burning of the eye with hot metal, or with strong alkaline or acid preparations, are of not infrequent occurrence, and are often of the most dangerous character. The sight is sometimes

instantly destroyed by the destruction of the delicate tissues of the cornea, and when the lining of the lids is much burned a growing together of the burned surfaces in the process of healing is a most annoying occurrence and one which calls for constant watchfulness. Then, too, after severe burns the scars resulting cause a drawing and displacement of tissue which may produce great deformity.

If lime or other caustic, alkaline substances get into the eye they should, as quickly as possible, be washed away with water to which has been added a little vinegar; after which a most soothing application is olive or castor oil. If the injury is from an acid a free use of milk or a bath of lime water will be the proper thing at first.

Sympathetic ophthalmia is a disease set up in one eye as the result of severe inflammation or injury in the other. It is a condition of things much to be dreaded, for if the first eye is made blind by the injury, whatever its nature, there is the added danger of a total loss of sight through the inflammatory processes, which, if once set up, are sure to lead to blindness with more or less rapidity in the other. Injuries are far more liable to induce sympathetic ophthalmia than diseases. They should, therefore, never be allowed to pass in a careless manner. In all cases in which the injured eye has been rendered sightless, and especially if the inflammatory action set up is

severe and persistent, no delay should be made in having the eye removed. As long as it remains in the head it is a menacing danger, and the blow will fall sooner or later, — possibly months or years afterward. If removed, all danger from sympathetic inflammation is obviated, and the sightless socket can be supplied with an artificial eye, which, from the observer's point of view, answers every purpose of the original article.

Artificial eyes are but a thin shell of glass, and are so artistically constructed at the present day that they bear a wonderful resemblance to the natural eye, and can be successfully adapted to even the unpromising cases. Within a few years celluloid has been used in the manufacture of artificial eyes, but their only recommendation, as yet, is their cheapness as compared with glass. A well-made glass eye can be worn, if carefully used, only two or three years, when its former smooth surface becomes eroded and then produces irritation. When this occurs it should be cast aside for a new one.

CHAPTER VIII.

THE CARE OF THE EYES.

The importance of the question how best to care for the organs of vision and preserve them against the encroachments of disease and the injurious effects of misuse cannot but present itself as one worthy the highest consideration by every one. The thought of losing the sight, and being debarred forever from beholding the beauties of our natural surroundings and the faces of dear friends, is one so repellent to our senses that we shrink with instinctive horror from its contemplation. The eye, so delicately constructed and so sensitive in its every part as to quickly respond to impressions made upon any one of its tissues, would seem to be in constant danger from "enemies without and foes within." But nature has endowed it with a faculty of resistance which seems quite remarkable when we consider the extent to which this organ is abused by the careless and the unthinking.

Those who possess strong and perfect eyes, like those who enjoy robust health, are many times led, by an over-estimate of their power, to make excessive demands upon them, until the results of their indiscretion repeatedly warn them, by pain and other persistent symptoms, that nature has been outraged. Some heed the first warnings of approaching danger and are put upon their guard thereby, while others are only brought to a halt by the onset of violent and alarming symptoms.

Perhaps more frequent than any other cause of bad eyes is their excessive use on fine work, or in close study for hours in succession, and that, too, in poor light and close, unventilated rooms. When selecting an occupation for life, one should do so after a full and careful consideration of the special ability of all the organs of the body to withstand the demands which are to be made upon them.

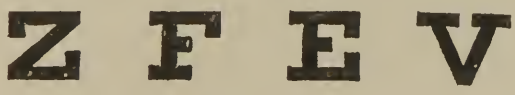
If there exists any inherent defect, either of an organic or of a functional character, in the eyes, which makes their use wearisome, or in any other way objectionable, such an occupation should be selected as shall make but small demand upon them. Those whose occupation keeps them in the open air, and especially where a wide range of vision is enjoyed, suffer very little from eye defects; while, on the other hand, students, artists, and those engaged in occupations allowing but little relaxation to the

accommodative effort, almost invariably suffer sooner or later, and to a greater or less degree according to the peculiar nature and the demands of their occupation. Now, as the eyes were not only designed to be used as the child of nature might use them, in viewing the

> "Far-off ocean's sunlit gleam,
> The distant mount, the winding stream,"

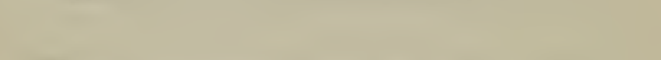
but also in the occupations of an indoor life, it follows that a judicious division of such usage is the better way, — the law of nature. Distant vision is a result of the relaxation of all accommodative effort, and the eye is at rest. Near vision means a muscular effort which if too long continued results in weariness and spasm.

With the eyes in a normal condition, and under ordinary circumstances, and with the aid of good light, of course, a person should be able to clearly and distinctly see letters of the size here represented at twenty feet from the eye.



While, at the ordinary reading distance of fifteen to eighteen inches, type of the size given below should be read without difficulty, if the person has not yet

arrived at the age of forty-five; i. e., has not become *presbyopic.*


I had now been in the isle twelve months, and I thought it was time to go all round it, in search of its woods, springs, and creeks. So I set off, and brought back with me limes and grapes in their prime, large and ripe. I had hung the grapes in the sun to dry, and in a few days' time went to fetch them, that I might lay up a store. The vale, on the banks of which they grew, was fresh and green, and a clear, bright stream ran through it, which gave so great a charm to the spot, as to make me wish to live there. But

Taking these letters as a test, one can form an approximate estimate of the acuity of vision which he possesses. Should the eye not be able to read the large letters at twenty feet, the vision is not equal to the standard, and it would be well to ascertain, through the proper sources, whether the defect be due to faulty refraction, disease of the eye, or simply to a lack of perceptive power. It should be stated here that the fact of a person seeing the required letters at twenty feet is not always an evidence that hypermetropia does not exist, for sometimes the accommodative power is so great as to quite easily overcome a considerable amount of hypermetropia. It is on account of this strong and sometimes spasmodic action of the ciliary muscle, which controls the convexity of the crystalline lens, that it frequently becomes necessary to instil atropine into the eyes in order to bring out the true refractive condition in fitting glasses.

Hypermetropic people can see well neither at a distance nor near at hand. In consequence, when

reading, the book is brought near to the eyes, in order that the print, by appearing larger, may be more easily made out.

Myopic or near-sighted people can never see well at a distance, but by bringing the object quite close to the eyes perfectly sharp vision is obtained. When myopia is of high degree very much of the pleasure of existence is never realized until glasses are adopted which correct the deficiency. It is not an unfrequent experience of the oculist to witness the delight with which a myopic person expresses his appreciation of the glasses which, for the first time, reveal to him in their true form, relationship and beauty, the things about him.

I would here strongly emphasize the propriety — the necessity, even — of a perfect correction of all refractive errors by suitable spectacles, in order that the eyes may be the better prepared for the tax laid upon them in the performance of life's duties. The prejudice against the putting on of glasses which exists in the minds of many is as unwise as it is unwarrantable, for the eyes can never perform their function, either to their own good or the satisfaction of their possessor, while under the restraint of imperfectly seeing surrounding objects.

The amount of work which the eyes are capable of performing without detriment must be measured by the experience of the individual. As soon as fatigue

is experienced the work or book should be laid aside, and the eyes either closed for a while or directed to distant objects. In debilitated conditions of the system the muscular and accommodative apparati of the eyes are also weak, and their use should be in accordance with the general usefulness of the body. From a want of care in apportioning the demand upon the eyes to the condition of the rest of the system a strain of the muscles of accommodation and convergence may ensue, and the eyes become sensitive, painful and utterly incapable of the slightest application. Such a state of things is a source of much worriment to the sufferer and of annoyance to the physician, as its effects are liable to be persistent. Absolute cessation from all use of the eyes for a season, general tonic measures, the correction of any refractive error by suitable glasses, and perhaps travel, will eventually restore the lost tone to the eyes.

It is essential to the proper performance of the function of sight that a suitable supply of light should be dispersed over all objects coming within the scope of vision. The quality and quantity of that light is an important matter, and one which should be carefully considered in the construction of workshops and school-rooms. It is scarcely possible to be supplied with too much light, provided it is evenly diffused and comes from the proper direction.

As much as possible all work demanding continuous and close use of the eyes should be accomplished by daylight; and while the exigences and the usages of life demand that a large portion of our lives be spent in the midst of artificial illumination, close use of the eyes should as much as possible be desisted from, and this portion of our day devoted to relaxation and recuperation.

Next to the importance attached to a sufficient amount of light while using the eyes is the direction from which that light should come and its proper distribution. In the open air we are surrounded by an atmosphere of light. It comes from every direction, and every side of every object is thoroughly illuminated. Such a light, although the best for the pure function of seeing, is not, however, the best in which to apply the eyes to close vision. This can easily be tested by reading for a short time in an unshaded light out of doors. The eyes soon become weary and dazzled and the modified light, as obtained in a well-lighted room or under the shadow of a tree, is a most grateful change. The light which falls upon the book or work, whether it be natural or artificial, should come from behind, and preferably from the left side. This direction of the light, beside preventing dazzling from reflection, prevents a shadow being cast by the body upon the book or work, and that also produced by the hand, if the right hand

is used, as in writing. If the light comes from in front its dazzling effect upon the eyes is very uncomfortable. If the eyes are to be used at a bench or machinery placed in front of a window, a visor or shade should be worn on the forehead to prevent the light from entering the eyes directly.

As to the quality of the artificial light used for illuminating dwellings and shops, the preference should be given to that more nearly approximating daylight, and giving a steady, even and intense illumination. The incandescent electric light possesses these qualities in a greater degree than any others now in use. It is soft and, when steady, is at the present time the best for all purposes. It also has the advantage of being easily placed in any position desired for comfort and sufficiency of illumination. All kinds of artificial light lack the pure whiteness of daylight. Even the electric light is decidedly yellow when compared with sunlight.

The amount of heat given off by an artificial light is a matter to be well considered in its effect upon the eyes. Those which give off a large amount of heat, if near enough to the eyes to produce thorough illumination, are liable to cause congestion in the head and eyes. Gas emits the greatest amount of heat, petroleum oil the next greatest amount, while the electric light emits so little as to be scarcely noticeable. The electric light has the advantage, also, of non-combustion of

oxygen, and where lights are used to a great extent this is an item of considerable moment, for the air is kept much purer. From a hygienic point of view, therefore, the electric light has distinct advantages. The atmosphere remains unsullied and unheated, and by its greater volume of light the eyes are less strained.

In reading, the size and kind of type is a matter which should always be carefully considered. Very fine type is unsuitable for use, either in book or newspaper, and should be used very sparingly. If the lines composing the letters are fine the size of the letter must be correspondingly larger than type with heavier strokes. Clear, bold type, with fairly heavy leading strokes, should be universally adopted. The age is fast going by when haphazard methods of printing books are indulged in. Many of the best books at the present time are gotten up with special reference to the requirements demanded by the recent advances in optical science. As prevention is ever better than cure, so the preparation of reading matter in a way calculated to prevent as much weariness of the eyes as is possible is far preferable to attempts at a cure when the eyes have once become injured by over-exertion in attempts at deciphering illegible print. The paper should not be of snowy whiteness, but of a slightly creamy tint, the type bold and clear, with a spacing between the letters and words sufficiently wide to admit of each letter forming a clear image upon the

retina. The length of lines should never exceed three and a half inches, and even less than that is sometimes advantageous.

Position in reading is far from unimportant in its effect upon the eyes. The habit of reading in a reclining position, or after going to bed, as is the custom of some, is exceedingly injurious to the eyes. The associated movements of the eyes have to be performed under conditions entirely different from those demanded while in a sitting or erect posture, and the result is a fatigue of the delicately balanced muscles. The act of accommodation is always associated with convergence, and with convergence a downward direction of the eyes is instinctively assumed. Disturb this harmony of movement and pain and discomfort are sure to follow. The act of reading while reclining or lounging compels the holding of the book in an awkward and uncomfortable position, which also demands an unusual as well as unnatural position of the eyes. The reclining position also favors an excessive determination of blood to the head and eyes, which would prove deleterious.

Reading in railway and tram cars is another evil which should be strongly inveighed against, but which is so universally indulged in as to make an assault upon it seem almost powerless for good. The constant jarring motion, which makes the letters dance about in every direction, as well as the change

of focal distance which is continually taking place, makes a most extraordinary demand upon all the eye-muscles, as can very readily be seen and experienced by those who indulge the practice to any extent. Although it may seem to be a harmless procedure, and the temptation to snatch the time of transit to and from business to become conversant with the latest news or to read the latest novel be overwhelmingly great, yet if one is especially desirous of doing the best thing for his eyes let him listen to the warning here given, and be governed by the results of the united experience of all investigators and teachers upon the subject and desist therefrom.

Whenever reading, let the light be clear and so good as to prevent any effort or straining of the eyes to see distinctly. It would be a difficult matter to provide too much light, if great care is taken to have the source of light sufficiently screened from the eyes. Exposure of the eyes to the direct glare of a brilliant light is, in its effects, sometimes as injurious to the integrity of the retinal elements as gazing directly at the sun, and this has often been known to produce a permanent scotoma, or blind spot, directly in the centre of the field of vision.

Finally, in the exercise of the best judgment obtainable by reading and observation, be not too officious in the application of remedial measures of your own selecting to what may seem simple though

troublesome affections of the visual organ. It is far better to consult the physician as to the nature and proper treatment of the malady than to follow the countless directions given by sympathizing friends. Any and all applications made to the delicate structures of the eye should be so applied only under the direction and by the advice of one who understands the nature of the disease. The use of a simple wash of lead-water has, in innumerable cases, caused a permanent whitish deposit upon the cornea, on account of a slight abrasion or superficial ulceration of that tissue. Poultices, unwittingly applied to inflamed eyes, have repeatedly been known to destroy the eye in a few hours. The application of tea-grounds or of alum curds, so indiscriminately indulged in, has sometimes a ruinous tendency, for it often happens that what may appear to the sufferer, or his friends, but a simple conjunctivitis has turned out to be a deeply seated and very important malady.

The error should never be committed of supposing that because the eyes are strong and well they will, therefore, always remain so without any special care. Those who possess what may be termed weak eyes, though not necessarily diseased ones, are taught by the exigencies of their condition to be wary of excesses. Such people will often maintain the integrity of what amount of visual ability they possess, by their watchfulness and care, when stronger eyes

are forced to succumb through the influence of late hours, insufficient sleep and debauchery, — all of which tend to seriously affect the tissues and the functions of the eye in a specially marked and ruinous manner.

CHAPTER IX.

DISEASES OF THE EYES IN INFANCY AND CHILDHOOD, WITH THE RESULTS OF SCHOOL-LIFE UPON THE EYES.

In the diseases which affect the eyes of infants those which result from hereditary influences assume the greatest importance. They may be present at birth or become developed later on in childhood. They usually assume the same form or type as that exhibited by the parent from whom the disease is inherited, but notable exceptions to the rule are not uncommon. Ernst Fuchs, of Liege, in discussing the causes and prevention of blindness, mentions the case of a man made blind by infantile ophthalmia who had born to him two children, both of whom possessed only very imperfectly developed eyes. He also mentions another instance, where the right eye of the father was lost in childhood through inflammation of the iris and choroid, and in which the corresponding eye of his son exhibited the shrunken appearance

possessed by his own. Such instances are not few, and possess great interest in their bearing upon the question as to whether acquired defects can be transmitted to the children. The claim is made by some that children of parents not born blind, but rendered so in childhood, will always be born with healthy eyes, so far as the condition of the parent is concerned. Such a claim cannot be substantiated by the actual facts as revealed by investigation; while experiments made upon rabbits have shown similar results to those given by Fuchs.

Not only do the diseased eyes of parents tend to produce a disease in the eyes of the offspring, but constitutional and acquired diseases in the parent are also liable to produce a diseased condition of the eyes in the child. The most potent of these are scrofula, tuberculosis and syphilis. Scrofula is among the most frequent and all-pervading of the constitutional diseases. Its effect upon the eyes is especially marked, and blindness not unfrequently results from persistent and deep-seated ulcerations of the cornea which are caused by it. A characteristic and by no means trivial feature of these ulcerations is their persistency, and the liability of recurrence again and again, each attack leaving, as a permanent result it may be, an opacity of greater or less density and extent. The deeper tissues are also liable to become affected, especially the iris and choroid, so as to cause

weak and irritable eyes and often impaired visual acuteness. The eyelids may also become thickened and sore, styes frequently occur, and through a diseased condition of the follicles the lashes fall out.

Tuberculosis transmitted to the child may affect its eyes through deposits of tubercle in the choroid and retina, creating visual disturbances, while no other organ appears to be affected. Inherited syphilis affects the eyes of children in a variety of ways. The most noticeable, and among the most frequent, are inflammations affecting the layers of the cornea, producing what is known as interstitial keratitis. Many cases of blindness or greatly impaired sight are caused by this disease affecting either the cornea or the choroid, and the inevitable transmission of its numerous evils from parent to child render plain facts as to the marriage relation imperative, in the case of those who may be afflicted with this disease.

Among the earliest of the primary diseases to which the eyes of infants are subjected is purulent ophthalmia. This is a disease the great importance of which, in view of its destructive nature, demands our earnest consideration. Out of fifty thousand blind people in the United States, as reported by the census of 1880, fifteen thousand, or thirty per cent, have been blind since birth, presumably the result of infantile sore eyes. When we reflect that this great army of blind people have mostly become so through

the ignorance and neglect of parents, who, had they been aware of the serious nature of the affection and had promptly taken the proper steps in combating it, would have prevented so much dependence and misery, we can but feel that the time has arrived when, in the interests of humanity and of the state, a determined effort should be made to promulgate widely and efficiently such a knowledge of this and other common eye affections as shall place those who assume the responsibility of the parentage and rearing of children on their guard and render them responsible for the consequences.

It is the duty of every medical attendant upon the birth of children to use the proper preventive measures in all cases where a suspicion exists that ophthalmia may arise. But when his duties are over, and in such cases as are attended by no medical man, the parents or the nurse who may have the care of the child should, in case of redness and swelling of the lids or of a mattery discharge from the eye, at once, and without delay, call in the doctor. A few hours, in some cases, are sufficient to work irreparable damage.

Among the diseases of infancy and childhood which exhibit a strong tendency to produce unpleasant effects upon the eyes are scarlet-fever, measles and diphtheria. The effects of the former may be manifest in a persistent inflammation of the eyelids and a

general lack of tone in the eyes for many months afterward. Measles sometimes produce internal disturbances of an obstinate character, as well as a muscular weakness of the eyes. Diphtheria has a strong tendency to produce a paralysis of the eye-muscles, especially those which preside over the accommodation of the eyes; and this may become manifest either at the time or within from one to four weeks after the disease has run its course. Cases of this nature are very liable to be overlooked or misunderstood, and not infrequently the little sufferer is accused of stupidity or laziness, by his parents or teacher, because he fails to have mastered the lesson assigned him. The fact that there probably exists a paralysis, more or less complete, of the muscles of accommodation is never thought of, for the reason that such results upon the eyes of children, after the diseases mentioned, are but little known among the masses of the people. It should be remembered that even those very mild cases of diphtheria which pass as a simple sore throat are, almost as frequently as those of a severer type, the cause of such paralysis. Great care should therefore be taken that the real trouble from which the child is suffering be not overlooked.

If the child, by good fortune, escapes the diseases of the eye which characterize the first few years of his life, the advent of school life has a marked ten-

dency to usher in other diseases of no trifling importance to the welfare of the child. The demands which the present age is imposing upon the eyes of childhood, as well as upon the whole physical being, require the most considerate adaptation of all the means which skill and science can devise to render these demands as little harmful as possible. The unquestioned necessity of good eyesight in the pursuit of any business renders the discussion of the subject of the effects of school life upon the eyes of our children of the utmost interest.

The peculiar dangers to which school life renders the eyes liable are to be apprehended in the induction of trachoma or granular lids, in weakness of the eyes, and in the production of myopia. The former of these maladies results from continuous use of the eyes, especially in a damp and impure atmosphere, in rooms destitute of proper ventilation, and amid smoke and dust. An over-heated and crowded school-room is an abomination, and ruinous not only to the general health of the scholar, but his brain and eyes must suffer especial injury by his being compelled to spend so great a portion of his time amid such surroundings. Trachoma may be a curable disease when not too far advanced and the environment is changed, but other diseases induced by school life in such apartments may become a perpetual inheritance.

A weakness or a painful condition of the eyes is

frequently induced by the strain put upon them to see clearly and well under the restraints of an uncorrected refractive error. Hypermetropia is a not unfrequent refractive condition of the eyes of children, but it is one which is, at first, easily overcome through the flexibility of the muscles of accommodation and the yielding nature of the crystalline lens in childhood, so that the additional convexity is easily induced which enables it to focus the light-rays entering the eye exactly upon the retina. This effort, however, will sooner or later not only become very painful to the muscles concerned, but a reflex effect upon the nervous system is very apt to follow, and the child breaks down in the midst of a promising career. It is to this condition, and also to an unevenly balanced condition of the external muscles of the eyeball which may accompany this refractive error, that are due a variety of forms of nervous disorders, such as sick-headache, irritability of temper, St. Vitus' dance, and sometimes epilepsy. Squint, or turning of the eye inward, is, in eight cases out of ten, the result of hypermetropia, and is brought about by the excessive strain put upon the muscles of convergence. If astigmatism be also present, a complication of symptoms results, which renders the condition a still more troublesome one, and causes the eye to become even less able to withstand any prolonged use.

When unpleasant effects are produced by the use of

the eyes in the school-room, parents should, without unnecessary delay, consult the oculist, in order that the exact condition of the eyes may be ascertained and suitable glasses prescribed. No unwise scruples in regard to having children wear glasses should, for a moment, keep the sufferer from enjoying the benefits of that which brings relief. The increase of knowledge and a better understanding of physiological laws at the present day, as compared with fifty years ago, should effectually banish error and prejudice.

By far the most important of the evils to which the eyes of school-children are subjected is the production or increase of near-sightedness or myopia. As has already been stated, children are seldom born with myopic eyes. There may, however, exist an hereditary tendency in that direction which, as soon as the eyes begin to be used upon near objects or study, rapidly develops into a well-marked type. The use of the eyes in study, and especially under unfavorable conditions, has always a tendency to produce this condition, and will often produce it when no hereditary tendency to myopia exists. Its frequency is always in direct proportion to the amount of close work demanded of the eyes, and in schools and colleges it stands in direct relation to the grade of the school, and its frequency and degree rises from class to class. According to Dr. Cohn's statistics (Germany), in the village schools of primary grade it

was present in 1.4 per cent of the scholars, while in the universities it was as high as 59 per cent; also, in twenty-four classical schools and high schools it was found, on the average, in 15.5 per cent in the lowest class, in 55.8 per cent in the highest class. This percentage, as obtained by Dr. Cohn in Germany, has never been attained in this country, and from evidences derived from all countries it would seem that the people whose reputation for scholarship dates back the farthest are the ones with whom myopia has been most prevalent.

As myopia is undoubtedly due, in great measure, to unsystematic methods of study and faultily constructed school-rooms, in which children are obliged to spend so large a portion of their lives while pursuing their studies, there is no doubt but that the evil effects which result therefrom may and will be prevented by a more correct application of well-known physical laws, and the construction of school-rooms on a principle which admits an abundance of light from the proper direction, and which provides for ventilation on scientific principles, as well as the proper construction of desks and forms. The past ten years have been exceedingly fruitful in bringing about such improvements in school-room architecture, and in the instituting of systematic physical exercises, as makes the future outlook exceedingly favorable, not only to the more healthy condition of the

eyes of our children than in the past, but also to a more satisfactory physical condition generally.

It is a well-substantiated fact that the chief factor in causing myopia is a too close approximation of the eyes to the book or work. There are certain conditions which tend to bring about this approximation of the eyes to the object, chief of which are: deficient acuity of vision caused by opacities in or a hazy condition of the cornea, errors of refraction, insufficient illumination of the object, illegibility or smallness of the type, method of writing, bad construction of desks and benches; and, withal, a faulty position customarily adopted. All the factors here enumerated, with perhaps others not mentioned, should first be eliminated as far as possible, and then, by precept and skilful direction, the child kept upon his guard as to the proper times and methods of using his eyes.

As the period during which myopia is most liable to become developed extends from the first use of the eyes upon near objects up to the age of fifteen or sixteen, it is manifestly during this period of the child's life that a watchful supervision is most demanded, and will secure, if at any time, the best results. Care should be taken that the natural tendency to approximate the book and eyes be continually opposed, the book being held at a distance of not less than twelve to fourteen inches; and if this

cannot be done with perfect distinctness of vision, then suitable glasses should be worn. It is imperative always that the print be large and clear, for children especially require a larger retinal image of letters than adults. The hours of study should be properly chosen and properly apportioned, and should never exceed, in the earlier years, more than three hours in the twenty-four, and these should be mainly in the early part of the day.

Sex exercises no decided influence as regards the liability to myopia; recent statistics on a large scale made by a European investigator show, on an average, an equal prevalence among male and female scholars. Certain races, however, show a special tendency toward myopia, and it has been found that in mixed schools composed of several nationalities, all working under similar conditions, it is found in largest proportions among the Germans and the Jews.

That the progress of myopia can be controlled by a strict observance of certain hygienic conditions is a fact so thoroughly recognized at the present day that among workers in this field a persistent effort is being made to so eliminate the factors in its production and increase that in the years to come, although the natural tendencies may remain as now, yet myopia shall cease to be the progressive hindrance to the acquisition of a liberal education that it has heretofore been.

As regards the proper construction of school buildings with reference to the essential qualities which shall ensure good health and the perfect eyesight of the scholar, it would seem desirable that a competent medical man, who has made a special study of school hygiene, should constitute one of every board or commission appointed by town or state to superintend the erection of such buildings.

The location of the school building is of primary importance. It should never be located upon a crowded street; the grounds about it should include sufficient area to prevent other buildings from being so near as to in any way obstruct the full light of the sun on all sides. It should, if possible, occupy the most conspicuously healthy location in the city. It should never exceed in height two stories, on general hygienic principles. Each class-room should be so arranged that an abundance of light may enter from the left side and from the rear. Light entering the room from both sides alike is the most objectionable, for in such instances the dazzling produced by the cross lights will inevitably call for a greater effort on the part of the scholar to see distinctly, and it has been observed that in school-rooms so lighted scholars invariably suffer more from defective sight. The light should come preferably from the east and south-east; but circumstances relating to the location and surroundings of the school building must be taken

into account. The windows should extend from just above the level of the desks to very near the ceiling and should occupy a large portion of the left side of the room, giving a window surface equal to one-fourth or one-fifth of the area of the floor. If sufficient light can be obtained from the left side of the room alone, it should be derived from that location solely; but if such cannot be the case, the additional light should come from the rear, never from the front, and as rarely as possible from the right side.

As regards the proper construction of desks and seats, they must, in every case, be adapted in size to suit the scholar. The distance between seat and desk in the vertical direction must be but very little greater than the distance between the elbow and prominence of the thigh bone. This is about one-eighth of the height of the body. The edge of the desk should overhang the seat from one to three inches, so that the scholar is, perforce, made to sit upright with his back supported. In this way the eyes will be kept further from the book than if the seat be further from the desk. The height of the seat above the floor must be equal to the length of leg from knee to heel, its width and depth sufficient to wholly support the hips, and the back so adjusted as to give support to the loins. The surface of the desk should have a slope of one inch in five, and should have an adjustment

whereby the book in studying may be raised to the proper angle.

A strict attention to details which in themselves seem of an exceedingly trivial character has within a few years been proved of the greatest importance to the welfare of the scholar's eyes. If we bear in mind the fact that myopia, existing at first as a slight interference of visual acuity, has a strong tendency to increase with continued use of the eyes, until organic changes take place in the different tissues to such an extent as to cause blindness, and if we become cognizant of the fact that in addition to the ordinary disabilities and inconveniences which attend myopia ten per cent of all cases of blindness are caused by it, we shall the better appreciate the importance of all precautions, slight though they may seem, which are here recommended to be taken in its prevention.

Prof. Ernst Fuchs of Liege, in Germany, in an article upon the "Causes and prevention of blindness," published in the *London Ophthalmic Review*, offers some very pertinent suggestions relative to the subject under present discussion. He recommends, as very essential in the control of the various matters which influence the eyesight of school-children, a careful supervision by a competent medical man. He should systematically and carefully examine into all the conditions which influence the child's physical condition while in the school-room, and he should be

competent to carefully test and record the vision of each scholar, and this should be done at the beginning of each school year. It should be his duty, also, to indicate the special placing in the class-room of such of the scholars as may require it on account of defects of sight. To him, also, he says should be intrusted the care of seeing that each scholar who requires it is supplied with the suitable glasses needed for the correction of errors of refraction, and no glasses should be allowed to be worn except those prescribed by a competent oculist after a careful and thorough examination. He should also indicate the cases in which certain subjects of study should be abandoned on account of defective sight, or physical disability, and offer any recommendation to the parents of the child which may be required in any case.

It is not always possible to have associated with the school board, or board of examiners, a medical officer, however, and in such cases it is most desirable, and should in fact in all instances be required, that teachers in public schools be so conversant with the laws of health, and with the laws which govern the proper use of the eyes, that every precaution may be taken to guard against the numerous evils which are likely to beset the child in the plastic stage of his school life.

Judicious and systematic physical exercise should be an absolute requirement, for indirectly the mind is

quickened and the eyes are strengthened by such exercise. A satisfactory test of the scholar's vision can be made and recorded in a book for that purpose by the teacher or superintendent of the school. A set of test-types hung upon the wall in a good light is all the apparatus needed for such work. Place the scholar whose vision is to be tested at twenty feet from the letters and ascertain whether he is able to read the type designed to be read at twenty feet, testing one eye at a time, with the other covered. If he can his vision may be termed 20-20, or normal. If he cannot read the type intended to be read at twenty feet, then ascertain the size of type which can be read at that distance and note the fact. If the sight by such test is found defective, the fact should be reported to the child's parents or to those responsible for him, in order that with them may rest the responsibility of obtaining competent medical advice as to the nature of the defect, — whether or not it may be necessary for him to wear glasses, or to be restricted as to his studies, or to receive any other treatment.

If a systematic testing of the vision of scholars were carefully and conscientiously carried out, at intervals of three or six months, it would save from needless aggravation many of those cases of defective sight which would otherwise pass unnoticed until the increasing failure becomes an actual hindrance to further

study, and it would give an opportunity for the early and timely application of such remedial appliances, or treatment, as the case might require, and in this way progressive myopia would receive an efficient check.

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THE END.

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